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Astronauts at the End
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*Narrow Escape
in World War II*



STS-1
Commander
John Young

STS-134
Commander
Mark Kelly

JANUARY 2011

Your Ticket to Hollywood's Golden Age

Celebrate the greatest year in moviemaking history with a uniquely retro luxury timepiece.

Hollywood got it right in 1938. Just look at the list of films released or in production that year: *Gone with the Wind*, *Mr. Smith Goes to Washington*, *The Wizard of Oz*, *The Adventures of Robin Hood*. It doesn't get any bigger or better. Back then, screen idols created the gold standard for movie star style. Just hearing their names conjures an image of sophisticated cool: Cagney, Garbo and Leigh; Gable, Flynn and Tracy. We longed for that bygone era of elegance so much that we decided to build a time machine: the **Stauer 1938 Majestic Watch**.

A sleek tribute to Hollywood's Golden Age, this is the eye-catching timepiece that the screen's biggest stars might have flaunted at red carpet premieres or the Academy Awards®. After searching for the perfect face among hundreds of vintage watches, we finally found a co-star worthy of history's greatest leading men. At last, the **Majestic** is ready for its close-up.

The Hollywood remake that gets it right. The streamlined Art Deco design and unique display of the **Majestic** was inspired by a rare timepiece style of the 1930s. Wristwatches with digital indication used rotating discs instead of hands to show the time. Finding similar vintage movements in working order is near impossible. And even then, it can cost you a small fortune. But by painstakingly reproducing the complex design, we've given you a more accurate update of the stylish original... **for under \$100**. That's like getting balcony seats at a world premiere for the price of a matinee!

Coming soon to a wrist near you. Like all great film classics, the **Majestic** deserves to be seen. While such a rare design definitely appeals to fine watch collectors, this is a watch that was made to be worn. Inside, a reliable precision movement keeps the time and outside an easy-to-read dial displays the hour and minute through a triangular window in the gold-toned, stainless steel case. Strap it on and get ready for the compliments.

The **1938 Majestic** secures with a black leather strap and is water-resistant to 3 ATMs.

Your satisfaction is 100% guaranteed. We invite you to try the **Stauer 1938 Majestic** for 30 days. We're confident that it will captivate you, but if for any reason it doesn't, send the watch back within 30 days for a prompt and courteous refund. Please keep in mind that even Stauer can't keep a blockbuster like this in production forever. If you miss this chance to secure a piece of watchmaking history, you might just have to wait around for the sequel!

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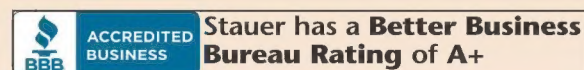
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ON THE COVER: In his portrait of two commanders, Robert Seale bookends the space shuttle era: Apollo astronaut John Young commanded the first mission in 1981; STS-134 commander Scott Kelly will fly in February 2011. More portraits of the shuttle era start on page 40.



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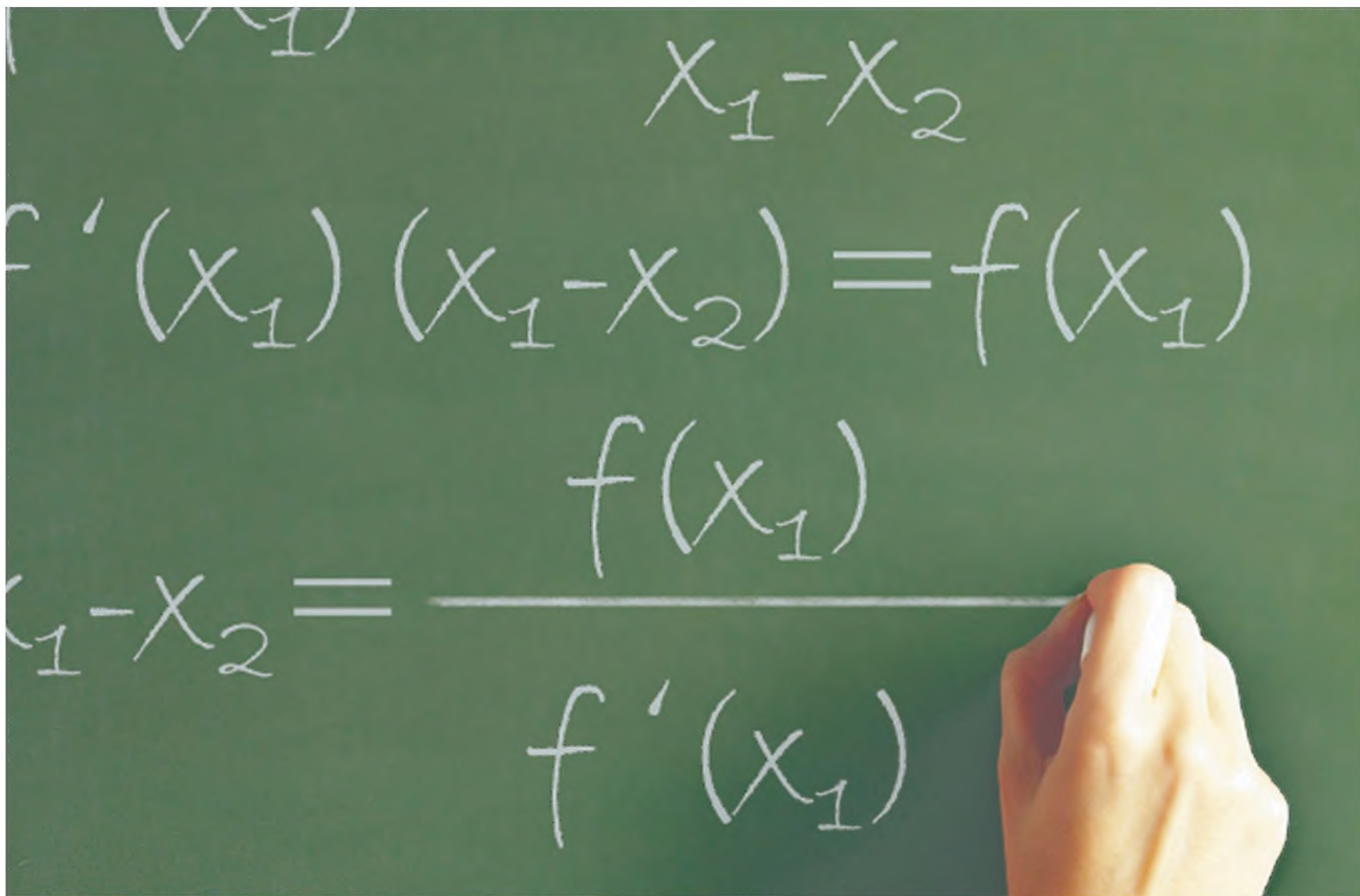
A new photo-filled book is a diary of life at the National Air and Space Museum.



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GET A GRIP ON CALCULUS

Calculus has made it possible to build bridges that span miles of river, travel to the moon, and predict patterns of population change. Yet for all its computational power, calculus is the exploration of just two ideas—the derivative and the integral—both of which arise from a commonsense analysis of motion. Master them and open a new world for yourself!

So why didn't you grasp calculus the first time? In school, many of us didn't continue with mathematics and so this great achievement remains a closed door. And for those of us who did, award-winning Professor Michael Starbird—coauthor of the acclaimed math book for nonmathematicians, *The Heart of Mathematics: An Invitation to Effective Thinking*—can correct the clumsy classroom delivery that hid its beauty. In **Change and Motion: Calculus Made Clear, 2nd Edition**, the concepts and insights at the heart of calculus take center stage.

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Our Family Albums

TWO RECENTLY PUBLISHED BOOKS offer views of the National Air and Space Museum that even some of us who work here have never fully appreciated. *The Legacy of Flight: Images from the Archives of the National Air and Space Museum* is a real treasure. Our chief photo archivist, Melissa Keiser, selected 132 photos from the more than two million in our collection for a presentation to accompany the opening of the Steven F. Udvar-Hazy Center on the 100th anniversary of the Wright brothers' first flight. Her presentation got such an enthusiastic response that many here thought it should be made available to a wider audience. This book is the result.

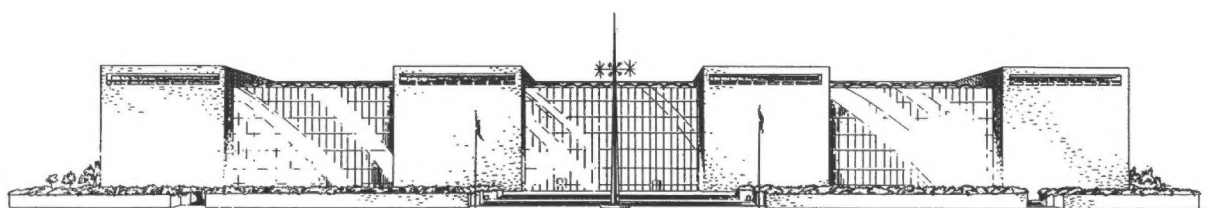
Although Melissa has characterized her selection as impressionistic, the book, with text by David Romanowski of the Museum's Exhibits Design office, is a fine representation of the archival collection (see Reviews & Previews, Sept. 2010). It is also a concise overview of flight's first century. One of the more famous images in the book is the grainy photograph of a B-25B Mitchell bomber that has just lifted off the deck of the USS *Hornet* on what was to become known as the Doolittle Raid, the U.S. Army Air Forces' 1942 retaliatory strike against Tokyo, led by Lieutenant Colonel James Doolittle. In the photo, a broad expanse of ocean stretches ahead of the bomber. Looking at it, you can imagine the country's state of mind in the months after Pearl Harbor, when the series of defeats in the Pacific made us all worry about what lay ahead. You can see this photograph and others

from the book on the magazine's Web site: airspacemag.com/multimedia.

The other book that offers an unusual look inside the Museum—and a long view back at the history of this magnificent collection and of the buildings that house it—is *Smithsonian National Air and Space Museum: An Autobiography*, a compilation of photographs with essays by Museum curators, published by the National Geographic Society. The excerpt from the book in this issue (page 62) provides only a few highlights of the effort to build and care for the largest collection of historic air- and spacecraft in the world. And the work is ongoing. We are completing Phase Two of the Udvar-Hazy Center, featuring the Mary Baker Engen Restoration Hangar and facilities to house the Museum's archives and small-artifact collections. We are anxious to have people visit the new hangar, where they will learn about the restoration process by watching specialists repair and preserve artifacts.

But even as we are finishing the expansion of the Museum, progress continues in the fields of aviation and space exploration. And as vast as our new Center is, it will not hold everything in the current collection, so we continue to form partnerships with other institutions to care for and display significant artifacts. With this emphasis on sharing, we will collect and preserve objects that represent the achievements of flight's new century.

■ ■ ■ J.R. DAILEY IS THE DIRECTOR OF THE NATIONAL AIR AND SPACE MUSEUM.





Clockwise starting top left: Caño Negro Wildlife Refuge; Tortuguero Park Canal Cruise; White Faced Monkey; Keel Billed Toucan; Pacific Ocean Beach; Rainforest Hike

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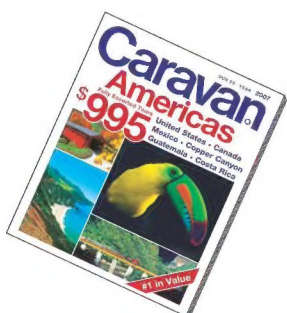
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"Flying Bathtubs Sell Like Hot Cakes" (Oct./Nov. 2010) reminds me of a family legend. My grandmother, Margaret Fleming, was said to have been courted by the general manager of the Aeronca factory, but she would not marry him. We still have her canvas flying cap with the Pennzoil patch. I am sending a photograph of her (below).

I learned how to fly conventional-gear aircraft (and to operate on skis) in a 65-horsepower Aeronca Champ.

Todd Deckard
via e-mail

Bitter Day, Bad Memories

I cannot convey the emotions I went through when I read Leonard Scotty's experiences in that 1958 crash at Ellsworth Air Force Base in South Dakota ("Fire and Ice," Above & Beyond, Oct./Nov. 2010). I was there that day, and I just missed being hit by that B-52.

I was a field service engineer supporting the operation of the tail turret's optical/radar fire control system. I remember that morning being, as Mr. Scotty states, 15 degrees below zero. It was my first winter in South Dakota, and being from Brooklyn, I had never experienced a

day as cold as that one. The road was icy, and I drove very carefully, and got onto the access road. When I got to the guard shack, I cranked down the passenger window and showed the guard my pass. As I did, I saw a B-52 on a head-on approach to the runway. This was one magnificent sight, and I was thrilled. Since I did not see any signs of trouble, I drove on to my office, which was only about a mile away.

By the time I got there I was told that an aircraft had just crashed near the guard shack. I knew it was the B-52, and it was one of mine, so I raced back to the scene because the tail turret housed four .50-caliber machine guns and there might have been ammunition on board.

Mr. Scotty stated, "It seemed to take the fire crews forever to get to us." I can understand how he felt that way, but I arrived within minutes of the crash, and by then the fire was out and the survivors were on their way to the hospital. Since I did not hear an alarm or see any emergency vehicles, I assume that the emergency vehicles and equipment were at the end of the runway around the time the aircraft stopped.

I do have a little problem with Mr. Scotty's statement that investigators "eventually" determined the cause of the crash. The Air Force seemed to be aware of that early on: Officers on the

scene informed me that the aircraft had been attempting to land with three engines out, due to ice clogging the fuel lines.

I have worked with aircraft and at airports for most of my adult life, but this crash is the most memorable experience of my career. Had I turned onto the access road 30 seconds later, the B-52 most likely would have run me over.

David Barlin
Marlboro, New Jersey



COURTESY TODD DECKARD

Margaret Fleming, looking sharp in an Aeronca C-2.



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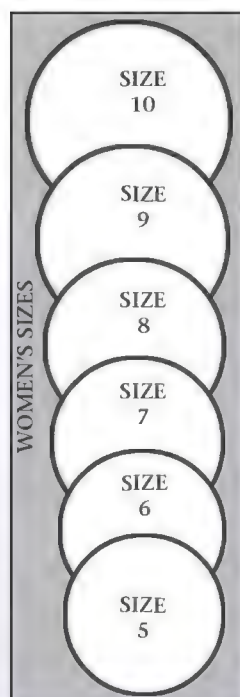


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AS THE FINAL SPACE SHUTTLE mission nears, **astronauts share their personal stories** from the past 30 years of spaceflights.

Also: We were riveted by this newsreel footage of aviation in the early 1930s – from primitive aerial surveillance to **daredevil pilots** to Evangeline Lindbergh taking a hop with her famous son.

Visit our Web site to see videos for articles in this issue: **U.S. airmen trapped in Yugoslavia during World War II** tell stories of their escape (p. 52); the **McDonnell XP-67 Moonbat** takes off on a test flight (p. 50); and the National Air and Space Museum is built in under a minute!

Drew Gaffney and Tammy Jernigan explore all angles on 1991's STS-40, the first Spacelab mission dedicated to life sciences.

I was an MP, almost 20 years old and on duty inside the flightline perimeter at Ellsworth Air Force Base the day the B-52 crashed. Because the crash site was secured that afternoon, the MPs could not be relieved at our shifts' end. Back then the security shacks were not heated, and three personnel ended up in the base hospital with frostbitten hands and feet.

Later that month I unearthed a chunk of the B-52 embedded in the mud. I had to wait until the ground thawed.

Wayne Eberhart
Bremen, Indiana

I Saw the China Clipper Fly

In 1935, the year the *China Clipper* made its maiden trans-Pacific flight ("Birth of the Clippers," Moments & Milestones, Oct./Nov. 2010), I was nine years old. In November, my mother and I boarded the SS *Lurline* (a Matson Navigation ship) in San Francisco and sailed to Hawaii. The captain announced that the *China Clipper* was on its way to Hawaii too, and if the time was right, we just might see it passing overhead. Well, we were not disappointed; we did see a tiny speck in the sky heading in Hawaii's direction and concluded it was in fact the *China Clipper*.

For a nine-year-old, it was something very magical to see.

John Maloney
Bend, Oregon

Airplanes in the Civil War?

Like Tom Crouch, I have an interest in the "prehistory" of aviation ("The Oldest Powered Flying Machine?" Above & Beyond, Sept. 2010). Early in the Civil War, Dr. R.F. Hunt, a Richmond, Virginia-area physician, submitted plans to the Confederate Engineering Department for a steam-powered fixed-wing aircraft. For years I have been looking for copies of the plans so I could build a radio-

controlled model of the craft, but I fear they were destroyed in the burning of Richmond. History could have been changed drastically if a couple of squadrons of these aircraft had been built and used for close air support.

Richard A. Banks
Crystal, Minnesota

One Clownish Airplane

Near the end of the RP-63 program ("Just Shoot Me," Oct./Nov. 2010), the training technique changed somewhat. The aircraft were no longer painted. The frangible bullets that the gunnery students fired at it had different colors. When the target aircraft landed, the colored marks were counted so it was possible to see which gunners had hit it and how many times.

In the mid-1950s, I was on extended temporary duty at the University of Utah. The school's Air Force ROTC program announced that it had acquired a warplane that would become the centerpiece of a monument. Program personnel prepared a ceremony for one Saturday morning. The monument was covered with a red drape. After speeches and band numbers, it was time to unveil the historic relic and recount the recent victorious conflict that we all etc., etc. With flourishes from the band, the drape was withdrawn. There, atop a granite and concrete pedestal, stood an RP-63.

After the ceremony, I walked over for a closer look. All over the sides of the warplane were little spots: green, yellow, blue, orange, and white.

Joe Hodder
Westfield, Massachusetts

A Field Full of Stories

"Brooklyn's Jewel: Floyd Bennett Field" (Oct./Nov. 2010) did not mention the work being done at the field by the members of HARP (Historical Aircraft Restoration Project). These National



Flyby

Dear Pacific Health,

I have been taking Claroxan® for about nine months, and I couldn't be happier with your product. An unnerving event spurred me to use Claroxan and I'd like to share that experience in this letter.

It was midsummer and a perfect day for flying. As any experienced pilot knows, the clearest days are actually the most dangerous days to fly because of the unusually high volume of traffic. I had been training with a new private student and we were going out to do some basic maneuvers to get him ready for his first stage check. Everything was going great. A wonderful takeoff and departure, then a smooth ride out to the practice area.

We got set up about 20 miles to the south of the field and decided to start out with some steep turns. We did our pre-maneuver checklist, then started to initiate a left clearing turn, after which we started to roll back to the right. We couldn't have turned back more than 40 degrees from our initial heading when I saw a Baron

heading right for us. I immediately yelled, "My plane!" and evaded with a diving right turn. Luckily, we came away unscathed.

The episode stuck in my head over the next several days: How did I miss that plane? Then one night, as I was relaxing after dinner, I came across an ad for Claroxan in an aviation magazine. A light bulb went off: Maybe my vision was starting to deteriorate! I thought about it, and there were some hints. I was squinting sometimes when trying to read road signs, and the spin on the ball at my tennis league had become just a little harder to pick up.

After about a month, I could see definite improvements in my vision. My vision was clearer, I could pick up on distant objects more easily and movements in my peripheral vision were easier to detect. That frightening moment a few summers ago lead me to Claroxan, and now I recommend it to all my colleagues and students. Keep up the good work, Pacific Health!

Sincerely,
Bob S.



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Park Service volunteers have been restoring many aircraft that have flown out of the field. Perhaps the most ambitious and historically important project is a full-scale static replica of the *Winnie Mae*, the Lockheed Vega that Wiley Post flew in his 1933 solo trip around the world. The flight began and ended at Floyd Bennett Field.

Solomon Glickman
 Brooklyn, New York

I'm probably in the picture showing Howard Hughes and his Lockheed Super Electra (p. 37). My father took me to Floyd Bennett Field in 1938 to see Hughes when he returned from his around-the-world flight. For some reason I ended up in the cabin for a closer look, and I think I remember a fuel tank that covered the floor. (I also think I may have even seen the *Hindenburg* passing over on its last flight the year before.)

Charles E. MacNeill
 Crystal River, Florida

The Original Wingsuited Man

"Jump. Fly. Land." (Oct./Nov. 2010) reminded me of an earlier practitioner of this mode of aerial transport. His name was Clem Sohn, and he was popularly referred to as The Batman. He flew clad in a suit of his own design, not unlike those employed by Jeb Corliss and his colleagues.

On the Internet, I found numerous references, one of The Batman zooming over Hanworth, England, jumping from 10,000 feet, pulling his ripcord at 1,000 feet, and landing in front of 100,000 spectators, who

rushed toward him the way the French at Le Bourget airport flocked to Charles Lindbergh after his 1927 transatlantic flight.

I also found a movie clip of Sohn soaring gloriously over Vincennes, France, on April 27, 1937. Sadly, his parachute failed to open and he fell to his death. He was 26 years old.

I saw Sohn in person, probably in 1934, performing at the Catawba County, North Carolina fair. He had just landed, and I was one of the first to approach him. I still remember his words to me: "Get the hell out of the way, kid."

Weston P. Hatfield
 Winston-Salem, North Carolina

Corrections

Oct./Nov. 2010 "Flying Bathtubs Sell Like Hot Cakes": The aircraft in the picture at the top of p. 34 is not a postwar 11AC Chief. It is a pre-war Chief, most likely a 65CA.

"Throttle Down": The lead parachute technician shown in the photograph at the top of p. 45 is named James Murrell, not Burrell.

Sept. 2010 "The Curious Case of Edgar Mix": The large photograph on p. 57, taken at the 1909 Reims airshow, does not show a Voisin but rather airplane 19, flown by designer-builder Louis Breguet.

June/July 2010 "The Real Top Gun": The photograph at the bottom of p. 34, published uncredited, was made by Sean E. Dunn.

"Tribute to an Aviation Journalist": The Messerschmitt shown on p. 51 is a Bf 109G-6, not a 109F.

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Landing Where X-Planes Trod

ROSAMOND DRY LAKE, 21 square miles of hardened clay, sprawls across the southwest corner of California's Mojave Desert. The lakebed's remote site made it an ideal emergency runway for secret 1940s



Some 100 aircraft, from Cessnas to warbirds to an Albatross (left), won an Edwards Air Force Base lottery: the right to land on a historic lakebed, off limits to civilians since the 1940s.

military aircraft like the Bell XP-59A and X-1, and it has stayed off-limits to civilians ever since.

Today, Rosamond is part of Edwards Air Force Base. "Its airspace is hot with military jets," says local pilot Roger Tonry, "so number one, you'll probably get busted going in there. Number two: You might get killed."

When the base's public affairs office announced it would hold a lottery to allow 100 civilian pilots to land on the base frequented by the most storied research aircraft in aviation history, Tonry submitted his application—along with more than 2,000 others. "We were wondering what to do in the off years,

when Edwards doesn't have an open house," says flight safety officer Bill Koukourikos, "and I suggested a civilian lakebed fly-in focusing on airspace safety." Major General David Eichhorn, commander of the base's Flight Test Center, agreed, then upped the ante: Let them be the first civilians to land on Rosamond.

Edwards personnel mapped out 17,000 feet of lakebed Runway 20 with tar-based paint. Koukourikos prepared detailed materials to familiarize pilots with lakebed landing procedures. "I've never seen so much landing zone data in my life," marveled HU-16B Albatross pilot Dave Cummings,

"especially one that's 21 square miles. I'm thinking, *Well, I can hit that.*"

Last October 1, aircraft began arriving at daybreak, guided by five controllers standing on a Ford stake bed truck dubbed Muroc Tower—a nod to Edwards' original name. "It didn't feel as rough as it looked," Tonry says of the lakebed surface. "But when you taxied, you knew you weren't on pavement. It felt like you were crunching dinner plates under the wheels."

Tonry's SIAI Marchetti SF.260 was joined by aircraft ranging from old Cessnas to warbirds to new Cirrus. Pilots partook of a pancake breakfast, then heard

briefings on the base's flight test mission ("intelligent risk taking"), the North American X-15's glory days, avoiding mid-air ("Bug the FAA until you find that traffic"), and the R-2508 restricted airspace, the site of bombing ranges, supersonic corridors, and low-altitude, high-speed maneuvers.

After lunch, thunderstorms popped up, and controllers quickly marshaled pilots, who in turn emptied the lakebed of aircraft. Ever mindful of safety, Edwards issued a press summary: "It was determined that an early departure was in the best interest of all attendees."

CHAD SLATTERY

The Wrong Wright Part

LAST YEAR, Palmer Wood visited the hangar and mini-museum of acquaintance Brian Coughlin, a vintage aircraft collector in Cazenovia, New York. Wood gave Coughlin a V-shaped piece of wood with a metal fitting that Wood believed to be a part of the Wright brothers' 1903 *Flyer*. "Palmer told me the story of his father and uncles, who summered near the Wrights' old hangar" in North Carolina, says Coughlin. "The boys raided the collapsed shed and took souvenirs. Most of the parts were returned to Orville but this piece lay forgotten in a trunk for decades."

Coughlin went straight to Peter Jakab, an associate director at the National Air and Space Museum who has studied Wright aircraft for most of his career. Jakab

figured it out in a heartbeat. "The piece is part of the actuator mechanism for the forward canard of the 1905 Wright *Flyer*," he wrote to Coughlin, and assured him "the 1905 Wright *Flyer*, the first true, practical airplane, is one of the most important airplanes in history."

Both Jakab and NASM senior curator Tom Crouch, also a Wright brothers scholar, know the backstory of Coughlin's piece well. Crouch says the brothers pretty much abandoned the 1905 machine in the Kill Devil Hills shed in 1911. In 1947, Edward Deeds of National Cash Register, planning to build a

memorial to Dayton, Ohio's role in developing industry and transportation, asked Orville for an aircraft to include in the display. Orville complied with the wings and a few components of the 1905 machine, which were stored in a Massachusetts museum that had hoped to rebuild the airplane. Orville then wrote to the Kitty Hawk residents and visitors who had confessed to retrieving pieces

of aircraft that had deteriorated in the remains of the shed. Orville asked that they send him the pieces; in return, he would send each some fabric from the 1903 *Flyer*. Most did.

"Uncle Thomas gave me my *Flyer* piece just after my father died in 1968," Palmer Wood told Coughlin, who has yet to decide what to do with the piece. "I took it to the Smithsonian and tried to match the part with the Wright brothers' plane, suspended 10 feet above me. No wonder I couldn't see anything that resembled the part in my trench coat pocket—it was from a different plane. I considered taking it to a curator to authenticate it, but I'm sure they would have promptly relieved me of it."

Says Jakab: "When the 1905 airplane was restored, this piece was missing and was reproduced incorrectly. The built-up framework of the actuators was used until 1905; they were solid after that. The Dayton *Flyer* has solid actuator parts." Now he can let the Dayton folks know about the error.



Teddy Coughlin shows off a model of the 1903 Wright *Flyer* and a piece of a canard actuator from the 1905 *Flyer*, recently given to his dad.

Lovely Lineage

AVIATION HERITAGE PARK in Bowling Green, Kentucky, restored a Grumman F9F Panther (see "Restoration: Kentucky Panther," Dec. 2009/Jan. 2010) to honor Kentucky native John Magda, the lead pilot of the Blue Angels when the team flew F9Fs, their first jet. Magda was killed in action in Korea in 1951 while he was flying an F9F. Last June, when the museum debuted the Panther, the current Blue Angels and their F/A-18s dropped in to check out their predecessor.



A 1950s Grumman F9F Panther, in Blue Angels livery, meets its second cousin twice removed, a 1980s McDonnell Douglas F/A-18 Hornet similarly garbed.

PATRICIA TRENNER

Thunderbirds F-16 Wannabe

ACTUALLY, IT'S A Harley-Davidson V-Rod tricked out as a star of the U.S. Air Force Thunderbirds precision aerobatics team. Motorcycle customizer "Doc Neon" (Alexander Evans) was commissioned to build one for a charity auction, and he liked the look of the bike so much he built a second one for himself. For years it has been a fixture in the showroom of Hal's Harley-Davidson near Milwaukee, but Doc recently put the bike up for sale.

Doc grew up in Chicago, where in high school he learned glassmaking, woodworking, and fabricating. At 17 he got his pilot's license and in the early 1970s was ferrying single-engine Pipers and Cessnas from Florida to Chicago for an aircraft rental chain. "Vero Beach to Northbrook with no radio," Doc recalls. "I wouldn't do that today."



Dare to be a standout in Memorial Day's annual Rolling Thunder tribute to POWs and MIAs, riding a Harley-Davidson with identity issues.

Doc migrated to Laguna Beach, California, tried stand-up comedy, and shared an apartment with the late comedian Sam Kinison. He found a book titled *Neon Techniques and Handling* and began incorporating neon in custom motorcycle retrofits and making motorcycles look like airplanes. Over the years he has done generic fighter aircraft designs and even a de Havilland Comet—"the most beautiful

airplane ever made," he says.

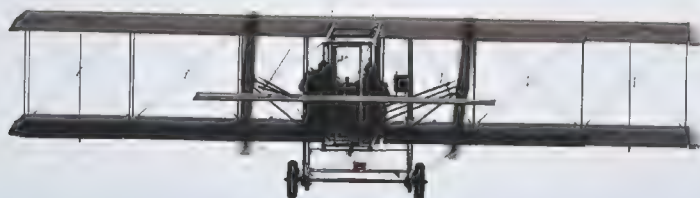
Doc admits that fashioning a motorcycle like an airplane isn't too practical: "The wings make it hard to park." His first Thunderbirds bike changed hands several times and the owners invariably call him when they break a fiberglass-coated flight surface. But Doc doesn't mind. "Everything I build is a piece of art," he says.

MARK HUBER

CELEBRATING CARGO

"Wright Flyer Heavy, Cleared to Land"

A WRIGHT MODEL B REPLICA, piloted by Mitch Cary and Rich Stepler, approaches the skyline of Columbus, Ohio, on October 2, en route to Rickenbacker International Airport. The flight, sponsored by the National Aviation Heritage Alliance and Wright B Flyer Inc., marked 100 years since the original Wright B made aviation's first cargo run, in which pilot Philip Parmelee delivered silk to Columbus merchant Max Morehouse. The descendants of both families were at Rickenbacker to welcome the replica and its crew.



On a reenactment of the world's first cargo flight (payload: silk), a Wright Model B replica carried advanced ceramic-matrix cloth used in composite aerospace products and a concept micro air vehicle from the Air Force Research Laboratory.

CSI: Prague

LAST NOVEMBER, as this magazine went to press, a group of Danish and Czech scientists were set to converge on the Church of Our Lady Before Týn on Old Town Square in Prague to solve a 400-year-old mystery: Who, or what, killed Tycho Brahe?

The Danish astronomer, a favorite in the court of Rudolf II, died in Prague in 1601. The circumstances of his death seemed peculiar: After a royal banquet, he developed a urinary tract infection and died 11 days later. No one voiced a suspicion of foul play at the time, but over the centuries a number of murder theories developed, usually fingering Brahe's German colleague, Johannes Kepler.

These remained no more than idle speculation until the 1990s, when samples of Brahe's hair taken during a 1901 exhumation were found to contain traces of mercury. That lent credence to the idea of poisoning, reviving the conspiracy theories. One of them gained wide exposure in the 2004 book *Heavenly Intrigue*, in which the American authors accused Kepler of



Astronomer Tycho Brahe would be spinning in his grave if he knew he would soon be exhumed – for the second time – in an attempt to solve the mystery of his death.

murdering his boss to get his observation journals.

Those journals were crucial in the development of *Astronomia Nova*, Kepler's treatise that laid the foundation for modern cosmology, verifying the Copernican theory of the universe (the sun at the center of revolving planets) and establishing the first two laws of planetary motion. And Kepler and Brahe had a stormy relationship—not surprising, since Brahe was a combative figure who wore a metal nose after he lost his own in a duel.

Says Jens Velle, the investigation's lead Danish scientist, "I don't know if it's possible to answer the question of how Brahe died," citing the ravages of time and Brahe's frequent contact with mercury in his work as an alchemist. But last November, Brahe was to be exhumed again, a process that required Velle to secure permission from the Catholic Archdiocese of Prague, the city of Prague, and federal antiquarian authorities.

Velle hopes the results, which may take up to two years to properly analyze, will reveal something beyond just the cause of Brahe's death: "I'm more interested in how he lived." Velle, who has devoted much of his career to studying Brahe's work and achievement, says that a study of the tomb and corpse may reveal Brahe's medical history, diet, injuries, even his favorite clothing.

Velle also hopes to publish a replica of *Mechanica*, Brahe's guide to the astronomical instruments he invented.

FRANK KUZNIK

Richard Altman

EXECUTIVE DIRECTOR, COMMERCIAL AVIATION ALTERNATIVE FUELS INITIATIVE

RICHARD ALTMAN spent 39 years as a propulsion engineer at Pratt & Whitney before heading up the CAAFI, an industry-government alliance formed in 2006 to reduce aviation's carbon footprint by pushing development of alternative fuels.



Richard Altman admires a North American F-100A and a Pratt & Whitney J-57 at the New England Air Museum.

What's the most promising alternative fuel for commercial airliners?

There is no single silver bullet. We view this as silver buckshot. One of the advantages of biofuel is that it can be generated and manufactured locally. We're presently certifying from seed oil crops, and in the United States the crop would be something like camelina, a rotation crop for wheat. But the fuels will vary by region. Our goal is to make

sure we have all the processes that are required to be able to use those seed stocks as jet fuels.

Is there a challenge in getting airlines to use it?

The understanding of the long-term economic and environmental consequences [of oil-based fuel] has really blossomed in the last few years. The airline industry does not usually have a long-term focus; it's usually: How do I get to next month without going bankrupt? They clearly do have a long-term view now.

How does alternative fuel affect engine performance?

The whole idea of the certification is that it won't affect engine performance. Our fuels are a 50-50 blend of alternative fuel with petroleum fuel. The certification ensures that the engine doesn't know the difference.

Is 50-50 the limit for jet fuel?

No, we can go further. It's possible [someday] that we could be 100 percent bio, but it's down the road a bit. Nor do we have the supply.

Synthetic fuels have been around since World War II. Why has it taken so long for them to be pushed for aviation?

Cheap oil. The economics are the reason it didn't happen earlier. Now you've got oil that isn't so cheap, concerns are about what will happen in the future, and the environmental element is much stronger today. When I took this on in 2006, I was under the impression that if the price of oil dropped a bit, the whole thing would go away. It looked like a nice retirement job for me. But clearly it hasn't happened that way.

Read the entire interview at airspacemag.com.

In the Museum

STOPS ON A TOUR THROUGH AMERICA'S HANGAR

Flying Outside the Boundaries

IN 1931, as Charles and Anne Morrow Lindbergh prepared to survey overseas routes for Pan American Airways, Charles told a surprised Anne that she would be their radio operator. She later wrote in *North to the Orient* that the intricacies of Morse code reminded her of French dictation in school, and she had to “let the dark torrent of language stream over me without trying to stem the tide.” The initially reluctant Anne became so skilled at sending and receiving Morse code that she was awarded the National Geographic Society’s Hubbard Medal in 1935 for exceptional radio work.

The radio and telegraph key from that trip, as well as the Lindberghs’ Lockheed Model 8 Sirius and dozens of other artifacts, are among the items on display in the National Air and Space Museum’s Barron Hilton Pioneers of Flight Gallery, newly reopened after a nearly two-year renovation made possible by the generous support of the Conrad N. Hilton Foundation. The gallery, which commemorates the spirit and resolve of early pioneer pilots, features technological and social advances in civilian and military



In the Museum’s newly renovated Pioneers of Flight Gallery (below), an interactive game lets visitors “pack” the Lindberghs’ Lockheed Sirius (above) by selecting useful yet light items (right).

aviation during the 1920s and 1930s.

“They’re all pushing the boundaries somewhere,” says Dorothy Cochrane, one of the Museum’s aeronautics



curators, of the pilots who flew the airplanes exhibited here. During the 1920s and 1930s, pilots were “really proving aviation as a mode of transportation, as an important arm of the military, and as something that the general public could do,” she says.

In the gallery, the Lindberghs’ Lockheed Sirius appears to be afloat in its specially designed dock. It is fitted with its modified EDO floats, which were needed during the Lindberghs’ journey to Asia in 1931 and also for their 1933 transatlantic flights; on each, they landed on the open sea, bays, and rivers.

On their second trip, in 1933, the



Lindberghs flew a total of 33,000 miles while checking out airline routes and gathering information on weather conditions for Pan American Airways. Because of the duration of their trips, they had to be extremely careful of the weight of the items they packed. An interactive display within the gallery allows visitors to learn about and choose supplies and equipment they think the Lindberghs packed. If the airplane gets too heavy with selected items, the game starts over.

Other highlights of the gallery include the Black Wings display, on the history of African-American pilots in the United States; the first official Piper J-2 Cub; the Curtiss R3C-2 Racer that Jimmy Doolittle flew to win the Schneider Trophy; the Douglas World Cruiser *Chicago*, one of two airplanes to make the first flights around the world; and Amelia Earhart's Lockheed 5B Vega.

The Earhart section of the gallery covers some of the lesser-known aspects of the famous aviator's life after her solo Atlantic crossing. "She promoted the interests of women," says Cochrane, "and she wrote for magazines, counseled young female engineering students at Purdue University, and did fashion design."

One of the items on display is a flightsuit that Earhart designed for the Ninety-Nines, an organization for female pilots that was founded in 1929.



Public Observatory Project Stop by the Museum's east terrace and visit the National Mall's first observatory. Look through the observatory's telescopes to discover the phases of Venus, spots on the sun (using safe solar filters), craters on the moon, and other wonders of the universe. Hours: Thursday through Sunday, from 10 a.m. to 2 p.m. through January, weather permitting. For more information, visit nasm.si.edu/pop.



What's Up Receive regular updates on Museum events, read about artifacts, get detailed (and behind-the-scenes) exhibition information, and receive calendar listings, all by subscribing to the National Air and Space Museum's free monthly newsletter, *What's Up*. Sign up at nasm.si.edu.



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Although the women didn't adopt Earhart's design ("The women were all too individualistic," says Cochrane), the logo she devised is still in use today.

One of the stipulations of the Hilton donation was that the Museum create early childhood education programs within the gallery, "with the hope that future generations of young people let their own dreams soar to new heights." To

achieve that goal, the Museum will help its youngest visitors learn about aviation and spaceflight in a children's hangar located next to Earhart's Vega. Elsewhere in the gallery, young visitors can watch puppet shows, sing along with music, and explore vintage airplane models and games in toy boxes.

MARY McKILLOP

ARTIFACTS

Superior Sabres

DESIGNED AS A DAY FIGHTER, the North American F-86A arrived in Seoul, Korea, in December 1950. Soviet-built MiG-15s had been giving the slower F-80s a pummeling, but that would soon change; on December 17, swept-wing fighters engaged for the first time, and Lieutenant Colonel Bruce Hinton scored the first aerial victory over a MiG-15. By war's end, Sabres had destroyed almost 800 MiG-15s, at a victory ratio of 10 to 1. The Museum's F-86A was assigned in 1949 to the 4th Fighter-Interceptor Group at Langley Air Force Base, Virginia; most of its combat missions were flown from Kimpo Air Base near Seoul. It is currently on display at the Steven F. Udvar-Hazy Center in northern Virginia.



The National Air and Space Museum's F-86A Sabre is displayed in the markings of the 4th Fighter Wing, the first F-86 unit in Korea.

The Iditarod Air Force



"HEY, LAND THIS THING RIGHT NOW,"

I told the veteran Alaska bush pilot at the controls of a Cessna Skywagon that was boring into a headwind 300 feet above the frozen Yukon River.

"Yeah, well, the thing is," the pilot replied, "it's the skis, see? 'Cause I dunno how chunky it is down there."

I didn't know from chunky. My real frustration was that I'd been assigned to cover the 1999 Iditarod sled-dog race—1,131 miles, 26 checkpoints, 60 entrants, each towed by up to 16 Alaskan huskies—and I hadn't talked to a musher in three days. And now, directly beneath us, was the race leader.

"Just land a half mile in front of him," I said. "Then I'll jump out and grab a two-minute interview."

What happened next—or so the pilot later explained—was that, upon landing, the skis burst through a foot of "sugar snow," then encountered a chunk of ice canted at a ramp-like angle that would have delighted Evel Knievel, given the distance it catapulted the Cessna. During that brief thrill ride, sunglasses, three-ring notebook, and

roast beef sandwich broke free of gravity, climbing from the bottom of the windshield to the top.

When the musher caught up to us, he said only "Wow." Meanwhile, I'd forgotten all the questions I'd intended to ask. "Well, take care," I offered.

"Me take care?" he replied.

The pilot's name was—well, let's call him Mark. A member of the 30-aircraft Iditarod Air Force, he knew a lot of things. For instance: A musher's ash sled costs \$1,500, and his 16 dogs can be worth several thousand apiece.

"Meaning what?" I asked.

"Meaning that, say, the team below us right now is worth more than a 1976 Cessna 180 Skywagon."

On that 11-day March odyssey, I recall other highlights.

Day Five: Mark pointed to an airplane and said, "Look at that guy stuck in the snow. He'll give it full power, then he'll nose that thing prop-first into the ice, then onto its back."

"Shouldn't we try to help?" I asked.

"Nah," Mark replied. "I like watching guys wreck equipment. Kinda like an

Writers covering the Iditarod race have the best seat in the house: a heated airplane cockpit.

object lesson for professionals, like farmers who stick their arms into giant threshing machines." Disappointing us both, the pilot unstuck himself.

Right after our own takeoff from a checkpoint in Takotna, the Cessna briefly shuddered, then we heard some banging.

"Left ski," Mark said. "Dislodged, flappin' around down there."

"Can we land?"

"Planes always land," he said. "It's their nature to land. Course, you got some leeway in *how* they land."

It was our softest-ever touchdown. Mark glided in with the right wing dipped so that the left ski bore little of the initial impact. When it eventually struck the snow, however, the ski nearly ripped off, smacking the fuselage as it randomly pinwheeled astern. Still, I was impressed. "Nice job," I said. "My Limping Nancy landing," he replied.

"Limping what?"

"Kerrigan," he said. "Nancy Kerrigan. I got a Tonya Harding version too, but you probably don't want to see that."

Day Six: When we landed, it was my duty to cover the wings, tail, and engine cowling with canvas. The wind would often catch the canvas and transform it into the sort of spinnakers deployed on America's Cup yachts. Because I was usually treading on a frozen surface, the wind had little trouble dragging me significant distances. On one occasion, I fell face-first into a wing cover and began rolling in an attempt to flatten it. I could hear Mark braying. Then I realized I was a lot warmer than he was, and I remained happily inert, hoping he'd worry I'd been injured. He did not.

It was also my job to pre-heat the engine by setting ablaze a puddle of liquid Heet antifreeze in a sheet-metal pan attached to a dented flue. The process filled me with fear: There were always damp, dark, dripping streaks on the cowling, whose potential volatility was unknown. Eventually, I simply embraced Mark's fatalistic adoration of colorful aircraft mishaps and began speculating whether a Cessna conflagration would have the energy to



Getting the engines of the fleet started sometimes required two applications of liquid Heet; "One for me, one for the airplane," the author says.



instead on a frozen lagoon and were approached by two women on an immense Arctic Cat that was rocketing toward us as if establishing a land speed record. Both riders leapt to safety 100 feet away, but the momentum kept the snowmobile hurtling at us. It sputtered to rest a dozen feet shy of the left strut.

We remained grounded in Unalakleet

There were small patches of black open water below, interspersed with towering daggers of ice. I averted my eyes and stared at what was left of the horizon: The

windshield looked like someone was applying Wite-Out.

"Well, it's rime, actually," Mark explained. "Plus there's some on the wings. And maybe some induction icing." The windshield turned opaque.

"This isn't a major problem," he said, as if trying to persuade himself. "The Nome airport is huge, and I can land anywhere on the property with the skis." Then he flipped into my lap what looked like a thick novel and said, "Look up the frequencies for Nome. I'd do it, but I forgot my glasses."

I recall a powerful urge to urinate. Instead, I riffled through the book. Just as I found a list of Nome frequencies, Echo shifted to a new position in my lap, inadvertently thrusting a foreleg through every Nome listing.

We eventually located the airport, although Mark was displeased that the runway had been scrupulously plowed. At the last second, he jinked to the right to land on snow. In the process, one ski beheaded a runway light. A corrective interview with airport officials ensued, but I missed the spirited exchange because Echo and I rode into town in a veterinarian's minivan.

I won't say I kissed the ground when I reached my hotel. But I did kiss Echo.

JOHN PHILLIPS

There were small patches of black open water below, interspersed with towering daggers of ice. I averted my eyes and stared at what was left of the horizon. The windshield looked like someone was applying Wite-Out.

melt the ice beneath the craft itself.

Day Seven: At the checkpoint in Grayling, a veterinarian told me the temperature was minus 38—centigrade or Fahrenheit, he wasn't sure. When I grabbed the Cessna's door handle, it snapped like a candy cane and disappeared into deep snow. "There goes \$100," Mark said. I think he meant I should pay for it. But I noticed he wasn't searching for the handle. So I didn't offer.

Day Eight: Approaching Unalakleet, on the Bering Sea, we encountered a 32-mph headwind, and Mark aborted our first landing attempt at an altitude of maybe seven feet. We touched down

for two days. "The wind here doesn't blow, it sucks," Mark said. "Seriously, it flows east to west, from the Alaskan interior out to the Bering Sea." The town was large enough to possess a store, where I purchased a three-pack of fresh Jockeys. "I'll alert the media," Mark said.

Day Ten: We spent a day in the checkpoint at White Mountain, interviewing mushers. Late in the day, we agreed to take a passenger—a three-year-old, 45-pound husky named Echo, who had been K.O.'d by a sprained ankle. She sat alertly in my lap and stared out the windshield as we flew toward Nome, crossing the Bering Sea's Norton Sound.

How I Failed “Purdue’s Got Talent”

AT PURDUE UNIVERSITY, the school that produced over a dozen NASA astronauts, the aeronautical engineering department has a tradition: Each year during the walk to the graduation ceremony, the dozen or so graduates hide paper airplanes under their black gowns.

For Aeros, as we are more commonly known on Indiana’s West Lafayette campus, once the mortar board tassels are turned from right to left to signify graduation, we slip the airplanes out of our robes and launch them into Elliott Hall.

When told of this tradition as freshmen, my classmates and I had dreamed of elaborate paper airplanes, remote-controlled with powerful motors that could keep the folded contraptions aloft for days. But four years of hypersonics homework and rocket propulsion projects had buried the memory of that final design assignment. With only a week until graduation, most of us resigned ourselves to a standard paper airplane, with the possible addition of a few carefully placed paperclips for weight.

I, however, had a trick up my sleeve. While my classmates had interned at places like NASA and Lockheed Martin, I spent the summer at the Institute of Paper Science and Technology in Atlanta, Georgia. Seldom did the study of paper aerodynamics come up, but I returned to Purdue with a knowledge of paper grading, weight, and strength.

I might never climb into the cockpit of an F-16 or guide a space shuttle to a

landing, but I knew I could build the best paper airplane ever to fly over the mortar boards of Purdue University. And our new president wasn’t just any academic. He was Martin Jischke, a Ph.D. in aeronautical and astronautical engineering.

I left the fancy folding to origami artists and went about modifying other aspects of the classic delta design. A heavy-duty manila cardboard, used for

reduce parasite drag and increase range.

On graduation day, I was careful to avoid any direct questions about the airplane, shrugging off inquiries with “Oh, I just folded some copy paper.”

My classmates and I stood shoulder to shoulder as President Jischke announced, “The School of Aeronautics and Astronautics.” We moved our tassels over and pulled out our airplanes. Students, parents, and

professors pointed and laughed as a dozen paper airplanes flitted, twirled, and zipped through the hall.

One took off as though propelled by tiny turbofans, sailed over the heads of the Purdue deans who lined the stage, banked as if to show off its sleek design and solid engineering, then slid gracefully to the feet of Martin Jischke. All the Aeros had seen where it came from. They looked down the aisle at me as Jischke examined the airplane and set it at the top of his podium.

I watched Purdue’s 10th president pick up my creation, the product of four and a half

years of study and a summer of research. I only hoped that he would recognize the thought behind the design. Would he notice the angle of the ailerons, positioned to give a slight positive pitch moment? Or maybe he would appreciate how the delta wing prevented stall at high angles of attack?

While the laughter throughout the hall died down, he examined the airplane, held it up to the lights, and leaned toward the microphone. “As a professor of aeronautics,” he said, setting the craft on top of his podium, “I give it a C, at best.”

   JEREMY DAVIS



file folders, would provide strength and prevent flutter and the attendant loss of lift and stability. I had to push the center of gravity in front of the airplane’s center of pressure. Paper clips might have done the trick if I had been using standard paper, but I needed something with more weight. Quarters were too cumbersome. Pennies were too lightweight. A nickel was perfect. If the coin was placed at just the right point along the rib of the airplane, I could send the aircraft across my bedroom on a glide that Chesley Sullenberger would be proud of. The final touch: upturned winglets to

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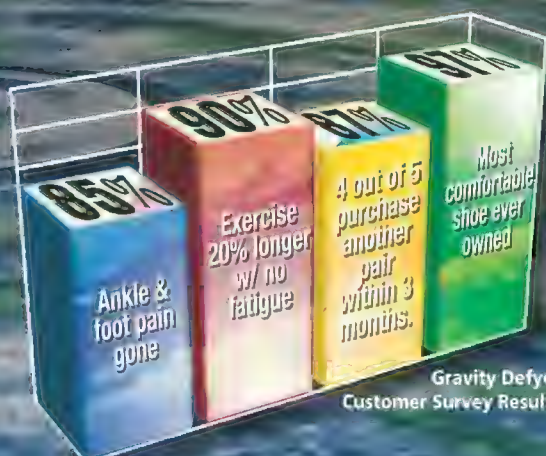
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The **Other** Gulf War

AFTER THE OIL SPILL IN THE GULF OF MEXICO, MORE THAN 200 AIRCRAFT TOOK UP THE FIGHT TO SAVE THE COAST. BY MARK HUBER

LESS THAN 30 MINUTES after the BP Deepwater Horizon drilling rig exploded in the Gulf of Mexico last April 20, five U.S. Coast Guard aircraft took off from New Orleans and Mobile, Alabama, and headed to the scene. In the weeks that followed, this small fleet grew into one of the largest and most intricately coordinated civil air support missions in the nation's history. Lasting more than three months, the mission involved more than 200 aircraft—from 70-year-old, radial-engine DC-3s to a NASA ER-2, the agency's version of the high-flying U-2 spyplane. Even a Navy airship, call-signed "Warlock 9A," joined the effort to protect the Gulf Coast from oil. The Coast Guard is often the agency charged with overseeing the federal response to maritime ecological disasters, and this response, according to chief of aviation forces Captain Michael Emerson, would grow to the size of the operation required by Hurricane Katrina.



USCG/PETTY OFFICER 3RD CLASS WALTER SHIN



US NAVY/MASS COMMUNICATION SPECIALIST 2ND CLASS ANDREW GERACI (2)



Most summer flying in the Gulf of Mexico was recon: From the cockpit of a Coast Guard HC-144 patrol plane (opposite), the armada surrounding the burning rig last June appears placid. Left: Even a Navy airship got into the act; at a New Orleans airport after an observing run (above), the pilot gets the signal to cut the engines.

As oil gushed into the gulf, radar-equipped aircraft flew daily missions to capture the big picture for the National Oceanic and Atmospheric Administration, whose job was to help forecast the oil spill's direction. Cruising at 60,000 feet, the ER-2, dispatched from Houston's Ellington Field, mapped the spill with a synthetic aperture radar. U.S. Coast Guard HC-130s also flew long-range surveillance missions, strip-mapping the area with surface-search radar, which had been used on ice patrols to distinguish between water and surface ice. As the spill grew, several commercial satellites helped with the imaging effort to relieve the load on the Coast Guard crews, as did a pair of Bombardier/Dash-8s equipped with sensors, cameras, and radar. One came from Transport Canada, where it had flown missions to

detect marine pollution; the other, from the Icelandic coast guard.

Interagency teams at area command centers studied the imagery from the recon flights to direct spotter aircraft. The spotters in turn directed airplanes spraying dispersant and boats skimming oil.

In a Cessna 182, Civil Air Patrol Captain Ande Boyer flew five hours a day, in rotation with other CAP pilots, from May 17 to August 27 to photograph oil boom—the floating barrier that either absorbs or contains oil—and to direct skimmers. “From the middle of June through August, it was like flying in a sauna,” says Boyer. “Even at 1,000 feet it was in the 90s, and you are sitting in a poorly ventilated airplane for five hours. It is just incredibly uncomfortable.” Patrolling inland waterways, estuaries, bird

sanctuaries, and other priority areas for boom placement, pilot-and-photographer teams were issued maps indicating where boom was supposed to be; their job was to report where it actually was, since the tide could pull it from its moorings. “Occasionally you would find it several miles away,” says Boyer. “Early on, there was a problem with boom disappearing. Another party would take boom and move it to where they thought it should be.” Aerial photographs helped planners get boom back to areas where it was most needed.

Boyer's aircraft was part of a fleet of CAP Cessna Skyhawks and Skylanes that flew photography missions along the Gulf Coast, producing huge computer-generated photomosaics that were evaluated daily by the U.S. Fish and Wildlife Service, which was



COURTESY COLUMBIA

Not their usual cargo: A Boeing heavy-lift Vertol 107 II (left) and Sikorsky S-61N, helicopters that transport crews and supplies to oil rigs, place sandbags to protect Louisiana barrier islands. Right: The area of operations to kill the spill.

monitoring the impact of the spill on wetlands and the effectiveness of boom. Each airplane shot more than 1,000 GPS-stamped digital photos a day. Over the course of 118 days, 150 CAP pilots flew 1,007 sorties, amassing 2,379 flight hours.

Early in the crisis, Emerson and others saw the need for a unified system to manage the air assets. According to the Federal Aviation Administration, helicopter traffic in the already congested gulf doubled to an

estimated 2,000 flights per day. The FAA set up a 900-square-mile zone governed by temporary flight restrictions (TFR) which eased the congestion by stipulating altitudes, entry points, and identification and communications protocol. Initially, a Customs and Border Protection P-3 AWACS (Airborne Warning and Control System) radar plane code-named “Omaha” tracked in real time all air traffic inside the TFR and provided conflict advisories to participating aircraft.

Steve Willey is an aerial firefighter for Queen Bee Air Specialties of Rigby, Idaho. Ordinarily he sprays slurry on forest fires from a two-seat, single-engine AT-802 Air Tractor. In the gulf, he used the airplane to spray oil with a dispersant called Corexit. “It had the texture and smell of baby shampoo,” he says. “It made bubbles.”

Called to Houma, Louisiana, by a contractor working for BP, Willey flew with a spotter plane, “usually an old 90-series King Air from Dynamic Aviation in Mississippi, based out of Stennis,” he says. “Most days we would find ribbons, maybe 20 feet wide, that would run for a couple of miles. We were just directed all over the place. You’d see the C-130s working a nice big block of oil. We were mostly on small patches and hopping from one patch to the next.”

Area command centers, established early



CIA AND NASA



by the Coast Guard to control air traffic, were under constant pressure to provide VIP and media flights and to allow news helicopters into the TFR. “Every governor, governor-elect, councilman, and senior officials in most of the states had to come out for a bird’s-eye view,” says Emerson. “Florida had more news helicopters than oil and they were fighting over [who could get the best pictures] of a tar ball.”

Emerson and his team also did their best not to disrupt the ordinary air traffic around the gulf, from commuter transports to airplanes towing banners over beaches to the fleet of helicopters that needed to make daily flights to the nearly 4,000 platforms still operating.

By June it was clear that more aerial coordination was required. The Air Force created an Aviation Coordination Command at Florida’s Tyndall Air Force Base. Over the course of 57 days, it managed 4,942 flights under Emerson’s command. Pilots were required to check in for a briefing and transponder code before taking off.

At its peak, 125 people worked in the Command, analyzing information, sched-

From Anchorage, Alaska, a U.S. Air Force C-17 delivered cleanup equipment to Naval Air Station New Orleans.



USCG/PETTY OFFICER 3RD CLASS STEPHEN LEHMANN

uling and tracking flights, and publishing pilot advisories. Representatives from BP, which paid for all flights; the Department of State, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the Department of Defense were in the command center and set the priorities for flights, to keep the oil off the beaches and away from entrances to bays and harbors.

Building the daily flight schedule was an exercise in détente. It started at area command centers, which would submit proposed mission schedules to the Tyndall command center around 6 p.m. each day. Then the negotiations started.

“Folks in New Orleans closest to the Houma command center have the source

A Basler BT-67 (DC-3 with turboprops) sprays dispersant in the gulf. By June, two DC-3s, four C-130s, and three Air Tractors had sprayed more than a million gallons.

right there in their back yard,” recalls Emerson. “Oil is coming into their water table. There’s no question that they were the most immediately impacted. But I don’t think anybody in Mississippi really cared about who was the most immediately impacted. They knew *they* were going to get impacted.”

Usually a master schedule of flights for the next day would be posted online every night by 8 p.m., but Emerson admits that sometimes the process lingered into midnight. “We had an unclassified Web site that was open to anyone,” says Emerson. “Even my parents could look at what the flight schedule was and say ‘Hey! I think that’s good’ or ‘My son’s an idiot.’”

In September, the oil was stanchied and the Tyndall command center stood down, having kept hundreds of aircraft flying for more than three months without mishap. Control of the handful of remaining flights reverted to area command centers.

In Houma, Airborne Support, Inc.’s Howard Barker parked his DC-3 dispersant sprayers. An oil industry co-op called Clean Gulf Associates pays him a retainer to keep them at the ready. After a long summer of fighting more oil than anyone had ever seen, Barker said that flying as part of a multitude of airplanes all with different jobs to do worked well, considering “there’s never been anything like this before.”



USCG/MASS COMMUNICATION SPECIALIST 2ND CLASS JOHN P. CURTIS

Major Surgery

How engineers altered a jumbo jet to carry the world's biggest airborne telescope. **BY TRUDY E. BELL**

On several nights this winter, in the frigid stratosphere over the Pacific Ocean, the pilots of a dramatically modified Boeing 747SP will relinquish control of the aircraft, and astronomical mission controllers will take over, steering the jumbo jet westward along a slightly curved star-tracking course at 520 mph. In the former passenger cabin where rows of seats used to be,

two dozen astronomers and technicians at computer workstations will sit poised for an event unprecedented in the history of aerospace.

At a computer command, a giant door in the rear fuselage, just behind the wings—a door nearly as wide and half again as high as one on a two-car garage—will open the aft left side of the aircraft, exposing an enormous cavity to the rarified atmosphere. Inside this cavity, a reflecting telescope with a mirror nearly nine feet across will point toward an invisible celestial object and gather its light at far infrared wavelengths, while just feet beyond the telescope's end, air will whip past at nearly the speed of sound.

This airborne observatory is SOFIA, the Stratospheric Observatory For Infrared Astronomy. SOFIA is a joint creation of NASA, which oversaw the extensive modification of the aircraft, and the German Aerospace Center DLR, which managed the construction of the telescope, the largest ever borne aloft. The 2.7-meter telescope is bigger than NASA's famed 2.4-meter Hubble Space Telescope, and even bigger than the 100-inch (2.5-meter) Hooker reflector atop Mount Wilson, California, which reigned as the largest telescope in the world from 1917 until 1948 (when it



It took innovative engineering on two continents to create a U.S.-German stratospheric observatory. The program will conduct its missions from Palmdale, California.

was surpassed by the 200-inch Hale on Palomar Mountain in San Diego County).

SOFIA also is an unparalleled undertaking in aircraft modification. The aircraft is flying with a hole in its side that extends nearly a quarter of the way around the circumference of the fuselage; the telescope cavity door is not a structural component. Just how was the 747SP reconstructed so that, absent a quarter section of its fuselage, it could withstand normal aerodynamic loads and buffeting at Mach 0.85 without the tail twisting off?



IT WAS IN THE EARLY DAYS of NASA that astronomers conceived of flying a telescope in the stratosphere to observe the

universe at far infrared wavelengths. Across a broad swath of the electromagnetic spectrum, from visible light to wavelengths measured in millimeters (1,000 micrometers), astronomers are effectively blind: Atmospheric water vapor blocks much of the infrared radiation from reaching Earth. To be sure, cryogenically cooled detectors on telescopes at mountaintop observatories can observe short infrared wavelengths, such as heat radiation. But even at the highest and driest locations, such as in Chile's Atacama desert, residual atmospheric water vapor precludes observations in most of the far infrared.

An aircraft flying in the stratosphere, however, is above 99.8 percent of the vapor. The stratosphere's dry cold (as low as -60 degrees Fahrenheit) can keep the entire structure and primary mirror at cryogenic temperatures without condensation or frost, although liquid nitrogen is needed when the airplane is on the ground just before and during takeoff to pre-cool the telescope to stratospheric temperatures before the cavity door is opened. Unlike a spacecraft, an aircraft periodically returns to earth; when it does, its cryogenics can be replenished, so an airborne observatory has a lifetime as long as that of the aircraft itself—

The telescope's nine-foot-wide mirror, shown partially covered before being moved into a NASA vacuum chamber for coating, is bigger than the Hubble Space Telescope's.

about 20 years or more. (Most space-based infrared observatories don't last as long; the Spitzer Space Telescope, for example, was launched in 2003 and ran out of cryogenics in 2009.) And unlike a ground observatory, an airborne one can be flown anywhere in the world for the best view of important celestial events.

In the early 1960s, NASA modified and flew several aircraft carrying telescopes to observe in the infrared; the last was the Gerard P. Kuiper Airborne Observatory (KAO), a modified Lockheed C-141A Starlifter carrying a 36-inch reflector. From its first science mission, in 1974, the KAO, operated from NASA's Ames Research Center at Moffett Field, California, revealed the structure of Pluto's atmosphere, the gas and dust between stars, and stunning cosmic processes involved in the birth of stars. It also discovered rings around Uranus.

The infrared marvels it revealed were so exciting that "astronomers immediately began wondering what they could do with a telescope that could collect roughly 10 times more light," recalls Edwin Erickson, KAO's facility scientist at Ames and later SOFIA's first project scientist (now retired). Erickson described the potential of such a telescope in a 1980 paper, and



SOFIA dwarfed its 1970s-era predecessor, the Kuiper Airborne Observatory, at an open house (above) at NASA's Ames Research Center in 2008. At left: Ames engineer Nans Kunz (hands on hips) inspects part of the telescope's cradle in Augsburg, Germany.



NASA AMES (2)

sioned the KAO so its budget could be applied to the full development of SOFIA, which began in 1996.

“As a replacement for the KAO, the science community wanted the largest possible telescope that could be flown on the largest possible aircraft at 41,000 feet or higher for as long as possible,” says Ames’ Nans Kunz, SOFIA chief engineer from its inception until 2007. Like a family on a budget shopping for the best used car, NASA was restricted by its funding to a used aircraft. SOFIA’s basic mission specs immediately narrowed the aircraft candidates to a handful of then-available military cargo planes and large commercial airliners. After scientists compared the finalists for fuselage size, weight-carrying capability, and ability to cruise for hours at high altitude, the hands-down winner was a Boeing 747 jumbo jet. The 747 had a record of reliability in commercial service, readily available spare parts, and an estimated lifetime of at least another 20 years.

Most promising was the unusual short-body 747SP, or Special Performance model, produced in the 1970s and 1980s. Only 45 were built, primarily for airlines wanting to offer long-range, nonstop service between cities nearly half the globe apart, such as New York and Tokyo. The 747SP has the same engines and wingspan as a full-length 747-100, and carries the same amount of fuel, but it is 48 feet shorter, making it lighter and thus longer in range. To compensate for the handling changes that shortening the fuselage produces, designers made the 747SP’s tail two feet taller and 10 feet wider than a standard 747’s.

Former project director Ken Szalai, inside the aircraft in 2007, compares the work to surgery that would transplant both a patient’s visceral organs and part of the brain.

by January 1986, Ames had established a SOFIA study office. Over the next decade, Ames scientists tested models of several open-port designs in wind tunnels. In 1995, NASA decommis-

THE SINGLE BIGGEST AERODYNAMIC CHALLENGE NASA engineers faced was modifying the airplane so it could fly safely even with an enormous hole in its fuselage. That challenge broke down into several key imperatives, notably: not disrupting clean airflow over the fuselage and control surfaces; restoring the strength and stiffness of the fuselage after structural members were removed and a heavy telescope assembly was added; and minimizing acoustic vibrations.

Plenty of airplanes open doors in horizontal flight—to release bombs, parachutists, or cargo. But they don’t continue to fly with open cavities for eight to 10 hours at a stretch, they typically don’t fly in the stratosphere, and they certainly don’t fly with a door as big as SOFIA’s. This telescope’s cavity is so huge in proportion to the size of the aircraft that the aerodynamic challenges in designing it were “in a different *universe* [from the KAO],” says former project director Ken Szalai of NASA’s Dryden Flight Research Center at Edwards, California.

Even to the untrained eye of a visitor walking around the outside of the aircraft, as I did last March at the 747’s new home in Palmdale, California, the scale of the challenge is startlingly evident. The full cut-out measures 14.5 feet wide and more than 16 feet circumferentially—although only about half of that circumference is exposed in flight because a rigid upper door and a lower flexible door (like the front of a roll-top desk) slide in tracks to follow the 22-ton telescope’s aperture as it points high or low. “It’s the largest cavity we’re aware of that’s ever been flown,” says Robert Meyer Jr., a former flight test crew member who is now SOFIA program manager at Dryden.

The cavity for the KAO’s reflector was forward of the C-141A’s wing and right behind the pilots, in what on a commercial flight would be first class. But in SOFIA, “the



LEFT & OPPOSITE: NASA AMES

telescope flies economy,” quips Erickson, because a far aft position for such a large open port reduced engineering complexity and expense. Only a third of the control cables—those for the tail—would need to be rerouted around the unpressurized and unheated telescope cavity. Most crucially, an aft position minimizes the chances of high-speed, energetic air dipping down into the cavity and creating destructive acoustic resonances—literally tones. “Think of blowing across the open top of a Coke bottle to make it hum,” says William Rose, who made open-cavity aero-optics and aero-mechanics improvements for the KAO at Ames and now as president of Rose Engineering in Nevada is doing similar work for SOFIA. The cavity was placed at the rear of the aircraft to keep it away from the most highly compressed and highest energy airflow—around the nose of the vehicle, the forward fuselage, and the wing leading edges.

The task of modifying the airplane was contracted to what is now L-3 Platform Integration in Waco, Texas. “We were brought in because we make heavy aircraft mods. We don’t touch anything smaller than a C-130,” says Greg Bruich, technical director for SOFIA’s mission controls and communications system from 1995 through 2003. (During the creation of SOFIA, the company was acquired and changed names four times—from Chrysler Technologies Airborne Systems to E-Systems to Raytheon Aircraft Integration Systems to L-3—so NASA

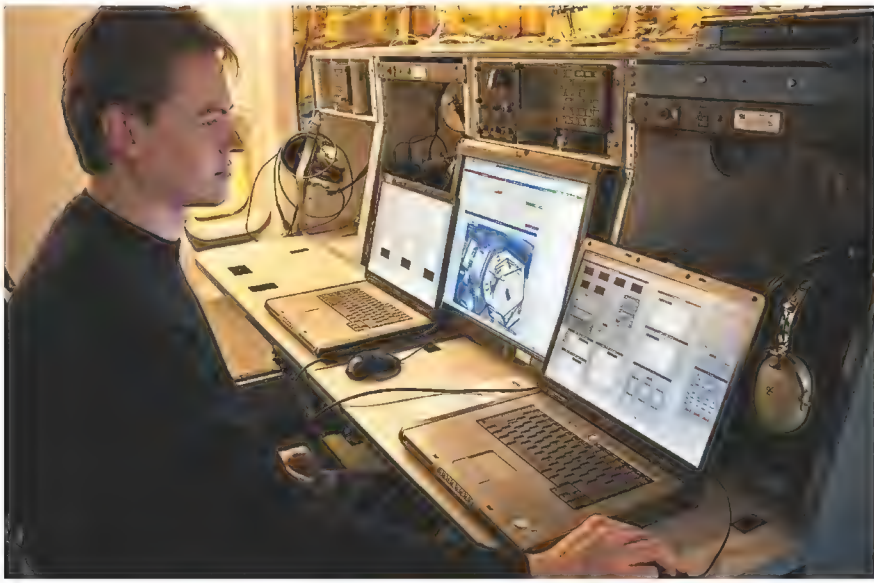
personnel “took to calling it just ‘Waco,’” Nans Kunz says.)

First, L-3 had to reverse-engineer every aspect of the aircraft’s existing design. The 747SP was designed in the late 1960s, long before the days of computational fluid dynamic models. Sure, Boeing had aircraft drawings, specifications, and analyses, but NASA needed a detailed structural model of the airplane to understand how loads were carried through the structure. “So we covered the unmodified aircraft with 350 strain gauges and other instrumentation, and then collected data as we repeatedly put it through wind-up turns, side slips, and other baseline maneuvers to measure loads on fuselage, wings, and tail,” recalls Albert Ruggles, L-3’s lead structures analyst for SOFIA. From that data, the L-3 engineers painstakingly built a computer model that represented every frame, sill, stringer, and other structural member—some 150,000 elements in all. The model gave the engineers a powerful tool to plan SOFIA modifications and simulate how various configurations would affect structure and aerodynamics.

For one thing, the engineers needed to model what would happen when the telescope cavity left only three-quarters of the fuselage holding onto the tail. A quick try-this-at-home experiment reveals why: Wearing gloves, grab the ends of an empty

At a facility in Waco, Texas, technicians install the telescope’s plastic-wrapped frame. Green panels are where the fuselage was modified to create the enormous cavity.





cylindrical. The asymmetry in turn changes the airflow, stresses, and structural loading on the rest of the airframe. Moreover, Doty adds, with all the telescope's weight concentrated in the back, "this structure is not loaded like a regular aircraft." Thus, L-3 needed to calculate how to redistribute strength, stability, stiffness, and shear stresses around the telescope cavity by strengthening the underlying skeleton structure, which is made up of hoop-like frames encircling the fuselage, longitudinal beams, and other internal supports. The engineers also needed to thicken the skin itself. "Some places right around the cavity [now] have several skin layers totaling more than half an inch thick," Doty points out.



CHAD SLATTERY (2)



NASA/ANTHONY WESLEY



Operators can monitor the telescope (top) from inside the 747, thanks to a bulkhead (middle) that keeps one section pressurized. Above: At first light, SOFIA saw Jupiter's heat. Thomas Keilig (right) manages SOFIA's telescope and science instruments.

aluminum soda can in both hands and try to twist it. As thin as the aluminum is, it resists a surprising amount of force. Next, cut a square hole in the can that extends a quarter of the way around the circumference. Now, crumpling the can takes far less twisting force. Why? "The skin of an airplane is more than just a big balloon with ribs that holds in the cabin air pressure," explains Dwight Doty, L-3's engineer in charge of aerodynamic analysis. "The airplane's fuselage is a semi-monocoque construction, meaning the skin is mounted to an underlying skeleton. The skin carries pressure and shear loads—that is, forces that would tend to stretch, compress, or twist the fuselage—and distributes these loads to the stronger skeleton."

Even with the cavity door closed, I could clearly see that the door and the tracks along which it runs make part of the fuselage asymmetrical, raising the aft left side a bit and making it more

The interior of the telescope cavity also had to be mathematically modeled. When the doors on most bomb bays, or even on the KAO, open, the airflow is disturbed,

causing the airplane to shake noisily. With SOFIA's huge cavity, design engineers did not want shaking. Worse, says Kunz, "we didn't want a 747-sized organ pipe."

Under the right conditions, all cavities resonate acoustically, just like a musical wind instrument. "We were really concerned about organized tones," said aero-acoustics expert Rose. "You can't have that, because structures can be torn apart by pressure changes." The amplitude—or loudness—of the pressure variations changes with the square of the speed; the pressure fluctuations at 500 mph are 100 times greater than those at 50 mph. If fluctuations of that magnitude happened in a car with a window down driving at freeway speeds, "blood would be running out of your eardrums," says Rose. Such powerful vibrations would "quickly eat up the fatigue life of the aircraft's metal structure in a matter of *minutes*, not hours," says Dryden's Meyer.

Because mathematical modeling is less reliable for unsteady airflow than for, say, structural loads, the team collected data from wind tunnel tests on a 7-percent-scale model. “We knew we had only one shot at modifying the real thing,” says Doty, “so we bought another Section 46 from a sister 747SP from an aircraft storage yard in Oklahoma to practice on.” Section 46, the fuselage segment between the wing and tail, is the part that would hold the telescope cavity and new pressure bulkhead (separating the heated and pressurized crew and astronomers’ cabin from the unpressurized telescope cavity). L-3 flew the section back to Waco in NASA’s Super Guppy transport.

L-3 did not saw a hole in the side of the 747SP. Instead, engineers

WHILE L-3 WAS MODIFYING THE AIRCRAFT in Texas, the German DLR center was overseeing construction of SOFIA’s telescope in Bonn, Germany. The instrument was built primarily by MAN Technologie AG and Kayser-Threde GmbH. After being integrated and tested in Augsburg, the telescope was disassembled and shipped to Waco in a Beluga (Airbus A300-600ST Super Transporter). A crane gently lifted each major subsystem and lowered it into the modified aircraft’s telescope cavity. “It barely shoehorned into the opening,” Doty recalls. “It was a remarkable feat—almost like giving birth in reverse.”

In May 2007, after some significant structural test flights at L-3 were completed, SOFIA flew from Waco to Dryden for interior



LEFT: CHAD SLATTERY; TOP RIGHT: CARLA THOMAS/NASA



In December 2009, SOFIA flew for the first time with its door fully open. The aircraft is expected to be completely operational in 2014 and work for at least 20 years.

removed structural elements and panels and replaced them a few at a time, while taking an approach analogous to shoring up the walls of a house before digging a new base-

ment. Ruggles says that for the modification, “the plane needed to be in traction, so we put it in jig position,” a term for supporting the aircraft so there are no loads anywhere on the structure.

Once the aircraft was in position, Ruggles says, “we started by installing as much of the new skeleton first before taking out the old skeleton.” The installers first replaced frames, stringers, and other supporting members with beefed-up versions, then removed the originals. Same for the skin: on with the new, off with the old. At the telescope cavity, says Ruggles, “off came a regular panel, on went a panel with part of the cutout.”

After finishing the modification, the engineers faced a trial that was more challenging emotionally: giving the reconstructed airframe a “proof pressure” test by inflating it to 12.5 pounds per square inch (psi), 33 percent above maximum operational cabin pressure, to prove it could be safely pressurized in flight. “At first we heard a few light pops as skin panels pillowed out,” Ruggles recalls. “Then at about 12 psi, suddenly a loud bang made us all jump. But it turned out only to be severe thunderstorm winds slamming a door behind someone.”

completion. In January 2008, the flying observatory was relocated to the new Dryden Aircraft Operation Facility in Palmdale, about 40 miles from Edwards, which allows easy access for non-NASA and international personnel. Dryden will oversee SOFIA’s flight operations even after SOFIA program management moves to the SOFIA Science Center at Ames.

On December 18, 2009, SOFIA passed a major aerodynamic milestone: a daytime test flight with the telescope cavity door fully open, all under the watchful eyes of chase planes and ground cameras. And on the night of May 25-26, 2010, SOFIA passed a major astronomical milestone: while airborne at 35,000 feet, the telescope achieved what astronomers call first light, taking a look at both Jupiter and the galaxy Messier 82.

Both achievements were huge moments for NASA, L-3, and the German Aerospace Center. “If compared to human surgery, that aircraft went through the equivalent not just of a heart-lung transplant, but also replacing your liver, kidneys, and part of your brain,” says Ken Szalai. SOFIA has run far beyond NASA’s originally projected schedule and budget; its current development cost, \$1.1 billion, is about triple the budget NASA originally projected in 1997. But Szalai is not bothered: “In doing something this close to the edge of the unknown, there is *nobody* who could accurately estimate it,” he says.

Last summer, the SOFIA Science Center announced the first 75-hour block of observing time for basic research between March and August 2011. The center received 59 proposals from 31 institutions for more than triple the number of observations that can be made during the first block of time. ✈

THE NEW AFGHANISTAN AIR FORCE

HOW THE U.S. MILITARY IS TRAINING AFGHANS TO FLY. BY STEWART NUSBAUMER

WITH VAST DISTANCES and forbidding terrain, few paved roads that are too often laced with explosives, and a resurgent Taliban throwing up more roadblocks, Afghanistan is a place where traveling overland is excruciatingly slow and extremely dangerous. Flying is quicker and safer, and, when the destination is a far-flung military outpost or remote provincial capital, often the only way to go.



The Afghan air force was formed with assistance from the Soviet Union in 1921, reorganized by the Soviets in the 1950s, and fully revamped along Soviet lines in the 1980s. When the Soviet occupation of Afghanistan ended in 1989 and civil war broke out, this air force, which once owned 350 aircraft, splintered into groups attached to five warring factions. By the time the Taliban took power in Afghanistan in 1996, only two air groups were left. After the U.S. bombardment in 2001, there were none. What the Soviets built, the Afghans broke into pieces, and the Americans bombed to smithereens.



USAF/SSGT MANUEL J. MARTINEZ



USAF/SSGT ANGELITA LAWRENCE

At Kandahar airfield, Afghans and Western coalition members celebrate the activation of the Afghan air force's second wing (above). Opposite: A portrait of Parwan province, taken from a UH-60 Black Hawk helicopter during a training flight with Afghan crew chiefs.

From what remained, the Afghan air force is rising again, this time on the wings of the U.S. Air Force. The more than 700 men and women of the 438th Air Expeditionary Wing, NATO Air Training Command–Afghanistan are training,

equipping, and mentoring all levels of the fledgling Afghan service. At Kabul International Airport, there is now an impressive \$183 million Afghan Air Force Headquarters and Air Wing, with dormitories, squadron buildings, a medical clinic, and a command center. On the flightlines at Kabul and Kandahar, you will find 40 helicopters—31 Mi-17s and nine Mi-35s—as well as 12 fixed-wing transports: five Antonov An-32s, one An-26, and six Alenia C-27s. By the end of 2010, four more Mi-17s and two more C-27s will join the fleet.

The U.S. mentors started arriving in

2007, and with their assistance, the Afghan air force has increased the number of missions it flies supporting the Afghan army. At first the increase came at a heavy cost: 17 Afghans dead in six helicopter crashes in 18 months. But things are improving. The 438th Air Expeditionary Wing statistics for Class A mishaps—those resulting in the loss of life or aircraft—show one in 2009 and as of October, none in 2010.

THE SOVIET-BUILT MI-17 helicopter is not a graceful-looking machine. In front it has two bulbous dust shields on the engine air intakes, and its fat body perches

on two skinny poles connected to bald tire feet—well, at least these tires are bald. Overall, it resembles an overstuffed cartoon chicken with buggy eyes.

Where U.S. aircraft are light, nimble, and sleek, Afghanistan's refurbished Soviet helicopters are heavy, strong, and ugly. But looks aren't everything. The Air Force mentors refer to the Mi-17s as "rugged trucks," and the Mi-35 gunships "rugged tanks." They say both helicopters are very reliable and simple to maintain.

At Kandahar Air Field, two Mi-17s sit on the apron. Both are about to embark on a mission, and I've gotten permission to go along. I am directed to the lead aircraft. Scrambling up its turquoise-painted ladder, I squeeze into the innards, a tight fit since

the helo is stuffed to the ceiling with 50 boxes of Remington sniper rifles we will be delivering. But the seats, painted a nauseous yellow, are easy to find. The intense colors, ornate metal handles and grooved panels, padded ceiling, and graceful curved doors

give the Mi-17 the feel of a souped-up 1955 Chevy, which would have been a contemporary of this helicopter.

We lift off, hover a few seconds—a brisk wind snaps us to port—rise higher, vibrate lightly, and accelerate forward at a speed

Walter Givhan, commander of the U.S. Airpower Transition Force, waits to board an Mi-35 attack helicopter; it will be the first flight in eight years in which an Afghan aircraft fires a nose gun and rockets. Below: Afghans perform six-month maintenance on an Mi-35 at Kabul.



BELOW: US ARMY/PETTY OFFICER 1ST CLASS DAVID M. VOTROUBEK;
LEFT: USAF/TSgt PARKER GYOKERES



that does not overwhelm. With nose down, we skim about 25 feet above a brown desert that changes to burgundy sand dunes sprinkled with sharp green bushes.

Afghanistan has stupendous natural beauty: snow-capped peaks, barren deserts with camel caravans, emerald valleys with rolling hills and rock fences, and sparkling blue-green lakes. To the north snakes the muddy Helmand River with banks of green fields. Farther north is a wall of mountains with hacksaw ridgelines, over which our Mi-17 will soon be climbing. First, however, we must make it past Lashkar Gah.

If Kandahar province is the spiritual home of the Taliban, Helmand province is its fighting home. And Lashkar Gah, Helmand's capital, is a bad hombre. The Taliban had recently gotten a heavy pounding in Lashkar Gah, so our preflight briefing ended on an uncomfortable question: Are the

At Kandahar, Lt. Col. Percy Dunagin points out flight plan details to Afghan airmen before a training mission last October.



USAF/SSGT ANGELITA LAWRENCE

Taliban there badly wounded and lying low, or are they angry and itching for a rematch? We'll know soon.

Our pilot, Ataullah (Afghans frequently go by a single name), is middle-aged, and was trained by the Soviets. Flying for 26 years, first for the Soviet-backed Afghan government and later for several factions during the civil war, he has had a lot of experience being shot at. The copilot is U.S. Air Force mentor Lieutenant Colonel Percy

Dunagin, a veteran of special operations. Dunagin's wry humor and sharp eye suggest he's ready for anything. The pilot and copilot communicate through a translator, an Afghan with chubby cheeks who looks anything but battle-tested. In the back is another mentor, Marine Gunnery Sergeant Carl Cole, manning a Soviet PKM 7.62-mm machine gun in the heavy wind of the open doorway. An intense, no-nonsense soldier who believes being a Marine drill instructor is the perfect job, Cole is drooling-ready for a Taliban attack. On the other machine gun is a young, laid-back Afghan.

"Apache here in seven minutes," Dunagin tells us over the radio.

The Apache, armed with an M230 30-mm cannon and up to 16 AGM-114 Hellfire missiles, is our aerial guard dog. The Afghan air force is a "beans and bullets" operation: mainly combat-support missions. Today's flight, ferrying materiel and troops around the country, is typical. Last summer, the Afghans took a step forward, using Mi-35s to provide combat escort for their Mi-17 transports.

"Gunny, see the Apache yet?" Dunagin asks.

Leaning out the door and craning his head around and up, Cole replies, "At 11 o'clock sir!"

As we begin our descent, Cole's eyes dart over the terrain, which shifts from desolate desert to isolated mud-walled houses. The Afghan gunner is up off the floor now, with both hands on his machine gun. Our helicopter swoops into a British forward op-

erating base, touching down on tiny concrete slabs surrounded by high blast walls. As the Apache circles overhead, Cole jumps out and races to several British soldiers. He returns and shouts into the radio, "Sir, they're not here. Maybe at the airport."

We lift off and scoot over the small town to reach the airport. Cole races out and returns with six Afghan soldiers. Then we shoot up and barrel out of Lashkar Gah. A few minutes later, the Apache peels off.

Flying north, our two helicopters crawl over the hacksaw-ridge mountains. In a natural bowl below is a pristine lake with green water. Although poor at maneuverability, the Mi-17 excels at high altitudes, which is crucial here.

On the backside of the ridge, we slide down to a desert plain and land at Tarin Kowt. The six soldiers disembark, and several Afghan soldiers arrive to unload the boxes of rifles into a truck.

Rolling down the gravel runway with 15 combat troops and gear piled to nearly the roof, our helicopter lifts and climbs. In five minutes we're sailing over a mountain range with sharp peaks. On the other side is a near-vertical drop to a wide plateau. We touch down just outside a small base, and with engines running and blades churning up a vicious sand storm, Cole sprints off with the 15 Afghan soldiers following and soon returns with a dozen carrying large green bags and long poles. Fifteen minutes later, we've reached the next base, but we're forced to circle for 20 minutes until two other helicopters take off.

After we land outside still another small and remote windswept base, there is another exchange of gear and troops. But these Afghan soldiers look different. Their eyes are intense, their bodies stiff. "Commandos," Cole says with a quick smile. And, with another change in our flight plan, he cracks: "Flying with the Afghans is like playing cards with my brother's kids—they keep changing the rules during the game."

We lift off and climb over the mountains, then follow a dry river bed that winds south to the Taliban stronghold of Sangin.

"Apache at 3 o'clock," Cole tells Dunagin.

Ataullah whips the old Mi-17 into a swoop. Dunagin leans forward. The chubby translator's face turns green. Cole's trigger finger taps the side plate of his machine gun. The Afghan gunner's eyes scan for danger below.

AN ONGOING DISAGREEMENT between the U.S. mentors and the Afghan pilots is that the Americans want more training for future development, while the Afghans want practically none; they want to maximize operational flying. The disagreement over training versus operations is part of a larger cultural difference, with the Afghans less concerned with planning than with actually using their resources. In a culture of scarcity, thinking about the future is a luxury. It's natural that pilot training would take a back seat to flying. Colonel James Brandon, commander of the U.S. mentors in Kandahar (since redeployed), puts it this way: "The Afghan pilots' attitude is 'I've been flying Mi-17s for 25 years. The Americans come along with little experience and try to teach us.'"

"Building the air force is like building an airplane in flight," says Brigadier

Tarin Kowt, map in hand, he pointed out to the Afghan pilots that they had just clipped the corner of the field's gunnery range. Afghanistan President Hamid Karzai, who is flown in a formation of three Mi-17s, knows first-hand how badly further training is needed; after a particularly rough landing that almost killed him, he went back to flying on U.S. aircraft. After the presidential detail got the training they needed from the Americans, Karzai



LEFT: USAF/SSGT MANUEL J. MARTINEZ; ABOVE: USAF/SSGT ANGELITA LAWRENCE

General Walter Givhan, the 438th Air Expeditionary Wing commander. The U.S. mentors squeeze training in when and where they can, but they say it's not nearly enough. "There should be 25 percent training, but we're doing only one to two percent on helicopters," Colonel Brad Grambo, commander of the 438th advisory group, told me. (Grambo has since been redeployed.)

This operational force could use the instruction. While flying from Kandahar to Lashkar Gah, Dunagin had to use his radio to explain to the crew members in the other Mi-17 how to re-program their radio. And immediately after landing at

Top: Celebrating the opening of the second air wing. Above: Medics Mohammad Ali (left) and Joseph Lemons joke in an Mi-17. At the remote town of Azra, villagers watch Afghan police unload election material from an Mi-17, flown by Afghan pilots with U.S. mentors (right).

is now back with all-Afghan air crews.

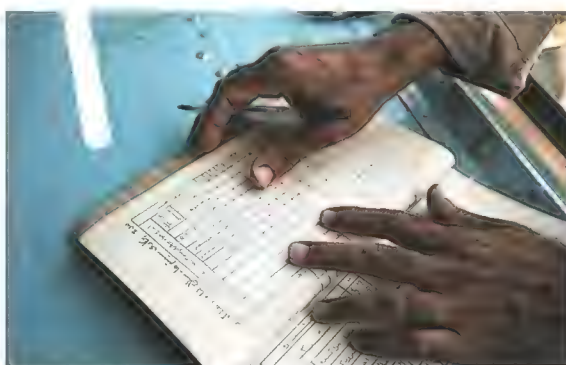
The Air Force mentors say the Afghan pilots are excellent stick-and-rudder fliers. But because of their limited training, their skills are restricted to fair-weather and daytime flying—nothing out of the ordinary. But they have recently started training and operating at night, and in August a



crew with night-vision goggles made the first night flight in a blacked-out Mi-17. This ability will enable the air force to fly the president in darkness, should it become necessary to hide him.



LEFT: USAF/SSGT THOMAS DOW; ABOVE: USAF/TSGT PARKER GYOKERES



USAF/SSGT MANUEL J. MARTINEZ

An Afghan airman documents a preflight check of an Mi-35 at Kabul (above). Top: Two Mi-35s take off from Kabul on a gunnery training mission last May; in the background, an Mi-17 lands.

FOR ONE WEEK in the winter of 2008, a selection board composed of two U.S. colonels and one Afghan general met in the Kabul airport to review the applications of 128 Afghan candidates for pilot training in the United States. All applicants were military officers with at least a high school degree. Each was given 15 to 20 minutes to address the board.

Today, Captain Robert Leese, chief of public affairs for the 438th Expeditionary Wing, says that the U.S. Air Force is providing the Afghans with more simulator time and training.

“What we were looking for was a high level of motivation—and proof!” says mentor commander James Brandon, who was on the selection board. “We looked into their background, into their educational level. We looked for that stick-with-it in their lives that showed they had the tools to succeed.”

The board initially picked 28 candidates, and then 17 more. Through a separate process, the National Military Academy of Afghanistan contributed 20 additional students. The selected candidates came from diverse military backgrounds: administrative officers, logisticians, infantry officers, pharmacists. Some had attended Kabul’s Air University, which the Taliban later closed, forcing the students into hiding.

That first group of candidates was sent to Lackland Air Force Base in Texas for English instruction, and then to various other U.S. bases for training in either rotary or fixed-wing aircraft.

A year later, the training continues. I



am at the shiny new terminal at Kabul International Airport, where a group of 10 Afghan men, ranging in age from early 20s to mid-30s, are about to fly to Dubai, then transfer to a flight to San Antonio, Texas. From there, they will be driven to Lackland for English language instruction. (Last year, the U.S. Air Force also set up Thunder Lab, an English immersion program for Afghan pilot trainees, at the air base in Kabul.)

The men, five dressed in subdued suits and the others in neat casual clothes, look ordinary, but they're not. And for them, today will always remain extraordinary.

"At first today I was very excited," says Abdullah, a stocky man with closely cropped hair. "Now I am very sad. I'm leaving my family for a long time." Most of the students will be away from Afghanistan and their homes for nearly two years.

Ibrahim, dressed in a conservative dark suit, takes a different view. "This is very important for our country," he says, "and very

The Mi-35 is armed with rockets (above); the U.S. mentors hope to get the Afghans proficient in flying the -35 for combat missions soon. Right: Lt. Faiz Ramaki looks pleased after flying a C-27 transport on an operational mission.

important for my family. We can't fail." One day the NATO forces will pull out. If the Afghan air force fails, the government it is fighting to defend could fail as well.

And the air force has a big problem: Its pilots are getting old. Ataullah, my Mi-17 pilot, is 48—and only three years older than the average Afghan air force pilot (by comparison, the average U.S. Air Force pilot is 33). The service desperately needs young pilots.

The men make their way across the glossy floor toward the departure lounge. As the line inches forward, their faces show their jumbled emotions—joy, distress, determination, gloom, excitement, trepidation. Kuldeep Kappor, an Afghan-American in-



structor at the Kabul Air Force Training School, offers quiet words of fatherly encouragement. U.S. Major Beth Kettle, the executive officer of the 438th (since redeployed), boisterously proclaims her faith in the men and thrusts her hand out for pumping handshakes. Handshakes? At the Air Force Training School several days earlier, I had asked a dozen students headed for pilot training: "What is your greatest fear when in the United States? Conquering





LEFT & OPPOSITE BOTTOM: USAF/SSGT MANUEL J. MARTINEZ

Once at Lackland, the students will endure the rigors of intensive English language lessons for nearly a year. Then the rotary students will head to Fort Rucker, Alabama, for flight training by Army instructors, and the fixed-wing students will be instructed at Columbus Air Force Base, Mississippi.

LAST JUNE, the United States' efforts to help build Afghanistan's military got some bad publicity: FoxNews.com reported that

says that all Afghan students who had left the base without authorization had been reported to the Department of Homeland Security, the FBI, and Immigration and Customs Enforcement. According to the Toronto newspaper the *National Post*, 22 of the 46 were later found to be in Canada (some were found on Facebook). Others were found in the United States and either deported or given conditional U.S. residence status. An undetermined number have still not been found. Smith says that Lackland



USAF/SSGT ANGELITA LAWRENCE



USAF/SSGT ANGELITA LAWRENCE

The American presence: U.S. air personnel meet Afghanistan president Hamid Karzai at a hospital at Bagram Airfield last May (above). Left: At Kandahar, Afghans prepare an Mi-17 for a training mission, while U.S. (in light camo) and Afghan airmen watch. When the Americans withdraw, will Afghanistan's air force be up to full power?

the English language? Passing the rigors of pilot training? Missing your wives and families for two years?" These Muslim men said their greatest fear was shaking a woman's hand.

a total of 46 Afghans who had come to the United States since 2002 for training in a variety of military skills had gone missing from Lackland over the years. David Smith, Lackland's chief of public affairs operations,

is still training Afghan military personnel. Since the AWOL alert was issued, he adds, "the Afghans have added a resident liaison officer to help students work through their issues."

As of October 2010, a total of 109 Afghan students have come to the United States for English instruction and training in flying. Of them:

- 17 completed instrument flight school,
- 2 completed helicopter training,
- 1 completed fixed-wing training, and
- 3 have completed all of their U.S. training and are back in Afghanistan. ✈

A full-page photograph of two men standing side-by-side against a solid brown background. The man on the left is older, with grey hair and glasses, wearing a white turtleneck under a dark suit jacket. The man on the right is younger, with dark hair, wearing a light blue shirt under a dark suit jacket. Both are smiling slightly. The text 'Shuttlenauts' is overlaid on the left side of the image.

Shuttlenauts

THE FACES OF THE SPACE SHUTTLE ERA.



BY TONY REICHHARDT | PHOTOGRAPHS BY ROBERT SEALE

To understand just how long the space shuttle has been flying, and how many generations of astronauts it has ferried to orbit, consider this: Of the six men assigned to the 134th and last scheduled mission (above), four weren't even born when the first shuttle commander, John Young, joined NASA in 1962.

Young, 80 (opposite, left), and his STS-1 pilot Bob Crippen, 73, are now retired, as are almost all the original shuttle astronauts – the Apollo-era holdovers as well as the “Thirty-Five New Guys,” as they called themselves, hired in 1978 to fly the new reusable spaceplane. The younger pilots, engineers, and

scientists who replaced those first shuttlenauts had the same fire for space travel, says Crippen. They were “Type-A personalities who want to press forward and do something adventurous.”

They were also a diverse bunch. What's most surprising about the first group portrait in our gallery is how similar the shuttle's first and last crews appear: all white men, mostly ex-military pilots. Thirty years ago, that was expected. Now it looks odd. The people who flew on the shuttle – 363 altogether – came from many backgrounds, races, and nationalities. They changed the face of spaceflight.



The Commander Families don't get much space-ier than Mark Kelly's. His wife, U.S. Representative Gabrielle Giffords of Arizona, chairs a key NASA oversight subcommittee in Congress. His twin brother, Scott, is also an astronaut, and by sheer accident of timing, will be on board the International Space Station when Mark (opposite) docks *Endeavour* there in February (on Twitter, Mark posts as *ShuttleCDRKelly*, Scott as *StationCDRKelly*).

In preparation for the flight, Mark Kelly took his STS-134 crewmates to Baja, Mexico, in November for a week of camping and team-building. If theirs is indeed the last mission (NASA may add another in 2011), the 46-year-old ex-Navy pilot says his crew plans to mark the end of the shuttle era in their own way. "But," he says, "I can't tell you what it is."

Station Builders In this century, the shuttle's main job has been constructing the space station, and every astronaut has contributed in one way or another. Left to right: Ken Cockrell commanded the 2001 *Atlantis* mission that delivered the U.S. Destiny lab. Spacewalker Bob Curbeam helped attach it to the station, and went back five years later to install one of the outpost's large truss segments. "Suni" Williams has already served one six-month tour on board; she will return in 2012 (in a Russian Soyuz vehicle) as the station's commander. Leroy Chiao lived on the station following the 2003 *Columbia* accident, when only two people were on board and resupply flights were so limited that food had to be rationed.







The Women It began with six pioneers – all hyper-achieving Ph.D.'s or M.D.'s – who in 1978 broke into what had been an exclusively male NASA club. Sally Ride (not pictured) was the first of the six to reach space. Anna Fisher (second from left), a chemist and physician, was fourth – on mission STS-51A in 1984. The first mother in space, she took a six-year leave of absence in the 1990s to raise her family. Fisher, now 61, and Shannon Lucid (who lived on the Mir space station in 1996) are the last of the original female astronauts still at NASA.

A total of 45 American women have flown on the shuttle. Just two – Pam Melroy and Eileen Collins (third and fourth from left) – became shuttle commanders, having both been Air Force pilots before turning to spaceflight. Mae Jemison (far right) followed a different path to orbit – a medical doctor and Peace Corps worker, she was inspired by *Star Trek's* Lt. Uhura to apply to the astronaut corps. When Dorothy Metcalf-Lindenburger, a 35-year-old former teacher (second from right), flew last April, she was the shuttle's last rookie astronaut. To show how far we've come since the days of the Mercury Seven: The shuttle era ends with a woman – 50-year-old former biochemist Peggy Whitson (far left) – as NASA's Chief Astronaut.





Flight 134 What makes a good space shuttle crew? STS-134 commander Mark Kelly (far right) says you start with the necessary mix of skills – a pilot, a robot arm operator, experienced spacewalkers. But beyond that, “you want a team that you think will work together well.” Here’s the crew that Kelly and his bosses in the astronaut office picked for the last regularly scheduled shuttle mission: Pilot Greg “Box” Johnson (next to Kelly) will be making his second flight. Kelly says the former F-15 pilot is a “good team builder, always a very positive attitude.” Continuing down the line: Two-time space station resident Mike Fincke has spent a year on the ISS, but this will be his first shuttle ride (his other launches were on the Russian Soyuz). Italian Roberto Vittori has also visited the station twice, and he too will be launching on the shuttle for the first time. The European Space Agency astronaut has known Kelly since test piloting days. Drew Feustel will take his first trip to the station – his only previous shuttle mission was to repair the Hubble Space Telescope. And Greg Chamitoff will be flying on the shuttle for the second time. He lived on the space station for six months in 2008.





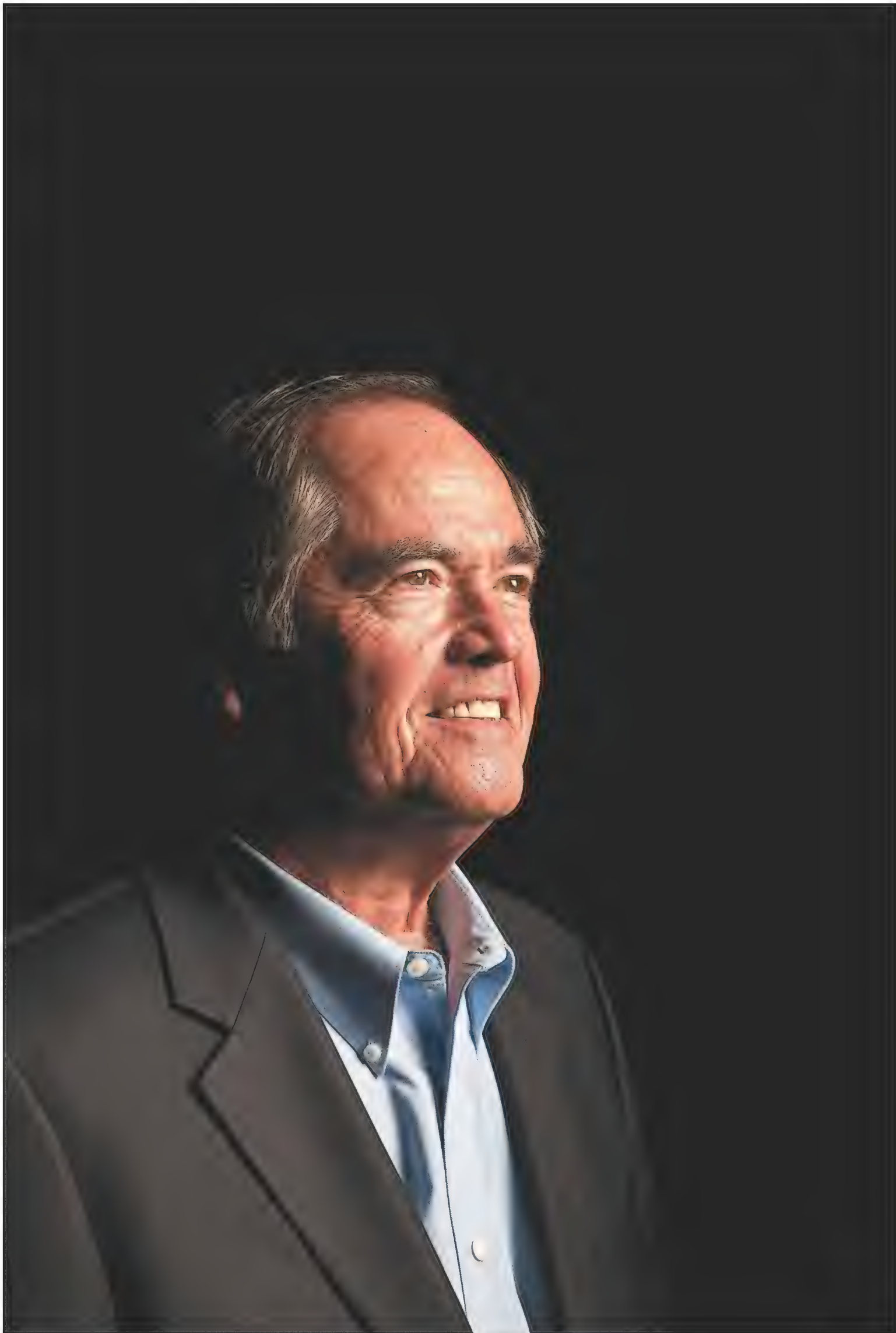


High-Timers Most of the human space-flight records not claimed by Russians (22 of whom have spent upwards of a year in orbit) are held by shuttle astronauts. With two long-duration stays on the space station – the second, in 2007, as its first female commander – Peggy Whitson is the U.S. record holder for total time spent in space: 377 days. Franklin Chang-Diaz (middle) made his first shuttle flight in January 1986, just weeks before the *Challenger* accident. Having been back six more times, he is one of only two people in the world to take seven trips to orbit (Jerry Ross is the other). Michael Lopez-Alegria holds the record for most U.S. spacewalks: 10. He also made the longest single flight by an American – a 215-day stay on the station in 2006-2007.

Mr. Shuttle Bob Crippen hadn't planned to fly for NASA. A Navy pilot, he signed up in 1966 for a military space station program that was later cancelled. So he transferred to NASA two months after the first moon landing, and waited. Assigned to the first space shuttle flight in 1981 with Apollo veteran John Young, Crippen became more closely associated with the shuttle than any other astronaut. He flew on four of its first 13 flights, three as commander. He went on to serve as director of the Kennedy Space Center in Florida, headquarters for shuttle operations, where, he says, "you see the same level of pride from the launch director down to the guy who pushes the broom cleaning up the place."

Crippen remains an unwavering shuttle lover. Will we regret sidelining the vehicle without a replacement in hand, just as we now kick ourselves for retiring the Saturn V moon rocket? "I think we will have that conversation," he says. ✈







Too Hot to Handle

McDonnell XP-67 Moonbat | BY STEPHAN WILKINSON

DAMN CONTINENTAL ENGINES. No matter how advanced an airframe is, and the McDonnell XP-67 was plenty advanced, you can't fly a fighter fast and hard if its engines are the product of one of the biggest weapons-procurement boondoggles of World War II.



Blended wing-body visionary James McDonnell sculpted the XP-67 in the early 1940s, promising a speed of more than 400 mph (above). Plagued by engine problems, it barely got off the ground (right).

The XP-67 was a spectacular-looking single-seat twin, the only piston-engine airplane that McDonnell Aircraft ever produced. The company completed just one XP-67 before jets left props in the dust and the Army cancelled the program in 1944. McDonnell's next airplane was the twin-jet FH-1 Phantom, followed by the F2H Banshee, F3H Demon, F-101 Voodoo, and F-4 Phantom II.

But the XP-67, casually called Bat and Moonbat—it didn't live long enough to get an official name—was a futuristic design nonetheless. James McDonnell, a pilot and aeronautical engineer educated at Princeton and the Massachusetts Institute of Technology, apparently became fascinated with the concept of making other airplane structures besides the wings into lifting surfaces. While he was the chief engineer for the Glenn Martin Aircraft Company, he sketched

at least one never-flown blended-wing design. Today the blended-wing concept has been greatly refined to mean a tailless flying-wing design, but McDonnell, while at Martin—and then later at his own company with the XP-67—tried to maintain a constant airfoil section on a conventional airframe, from the fuselage centerline all the way out to the wingtips. He included in the blended airfoil the fuselage-to-wing junctures, the engine-nacelle-to-wing interfaces, and even the nacelles themselves. From the conventional tail forward, the Moonbat was all curves. It had the skirted look not of a bat but of a flying squirrel.

McDonnell doubtless was also intrigued by the possibility of decreasing the drag created by the sometimes awkward conjunction of a wing, with its own lifting airflow, and a fuselage—or nacelle—that had entirely different ideas about where the flow should go. The interface usually created turbulence,



BACKGROUND: AIR AGE/BJORN KARLSTROM; BOEING (3)

CANCELLED

XP-67

Some ideas just won't fly.



The Moonbat had piston engines (left) for long-range flight, but the design anticipated jet engines for combat.

or interference drag. Most engineers found it easier to lessen such drag with gracefully curved wing fillets or straightforward 90-degree wing-to-fuselage interfaces, typically in the form of wings mounted on the midsection of the fuselage. In fact whatever interference-drag benefit McDonnell might have created was probably nullified by drag from the increased area exposed to airflow on what were essentially oversize fillets.

The engines dated back to 1932, when the Army decided it needed light, compact, high-specific-power, high-revving “hyper” engines ideally configured to be installed, in the fashion *du jour*, inside future bomber wings or fighter fuselages. The IV-1430 was designed by the engineers at the Army’s Wright Field in Ohio, and Continental simply built what it was ordered to: a two-valve, small-displacement, low-frontal-area, inverted V-12 with separate cylinders (World War I technology) intentionally running its glycol coolant very hot. Intended to produce a competitive 1,600 horsepower, the IV-1430s (also used on the Lockheed XP-49, a modified P-38) never put out more than about 1,060, even after a turbocharger was bootstrapped onto the engine’s single-stage mechanical supercharger.

The Continental was the only true hyper engine to see a modicum of production (23 engines total),

but by the time it finally flew, it would have been a nice little motor for the lightweight Air Corps pursuits of the 1930s. Long-range, heavyweight fighters and super-bombers needed a minimum of 2,000 hp per engine.

But it was the engine that Jim McDonnell had been led to believe would be perfect for the buried mounts on the XP-67’s wings. When he discovered it to be troublesome, hot-running, and down on power, he agitated to have the XP-67 given new engines, either Allison or Merlin V-12s. Sorry, the Army said, work with what you have. What McDonnell had were engines so poorly cooled that during initial taxi tests, both caught fire.

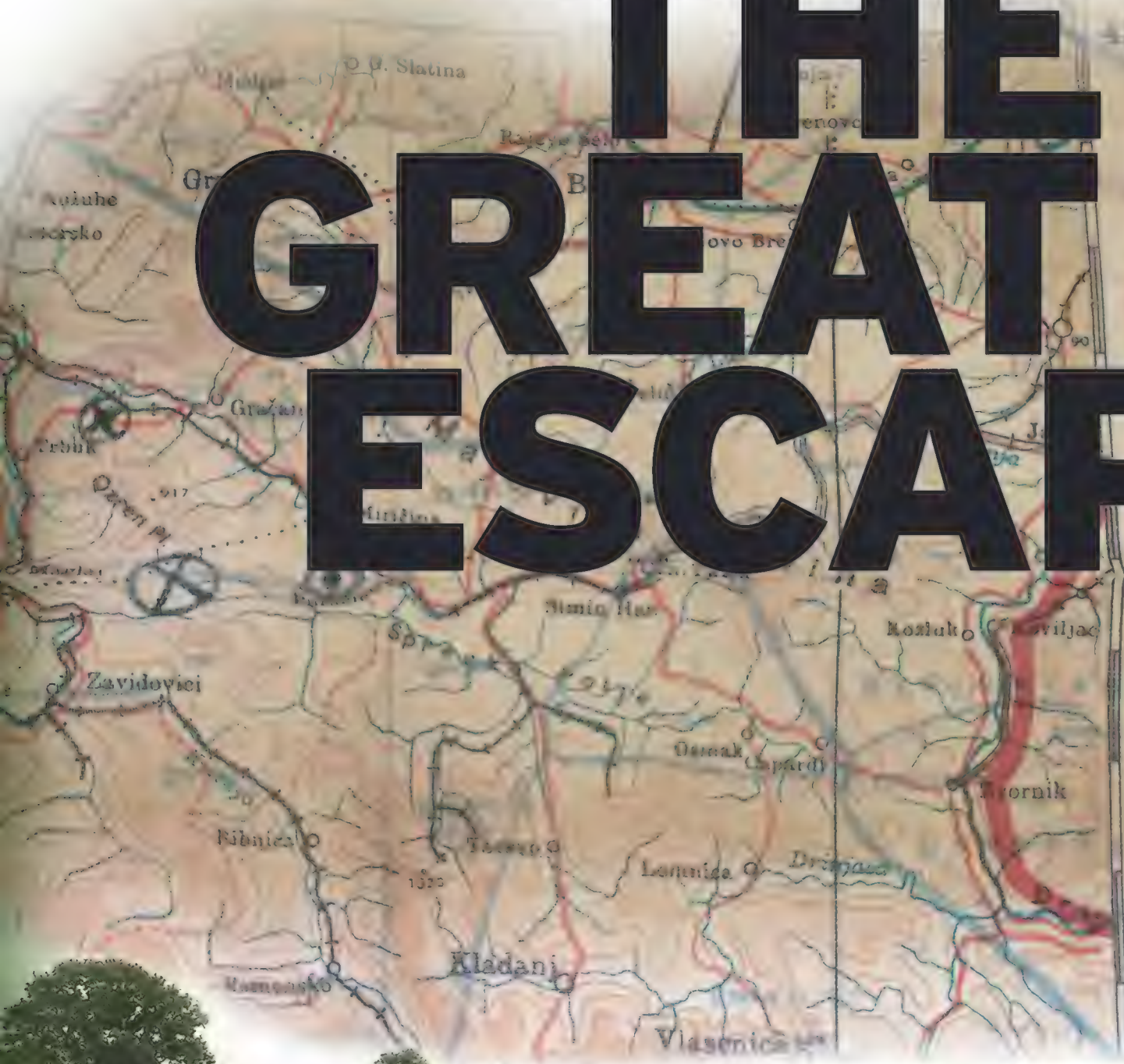
The XP-67 first flew in January 1944. After all of six minutes, yet more engine problems forced an immediate landing. It didn’t matter; by then the Moonbat had lost its mission. Conceived in an era when America saw a need to repel long-range German attackers, it was intended to blast apart bomber formations, but by the mid-1940s, neither the Germans nor the Japanese had any effective bombers left. With an intended battery of six 37-mm cannon—never actually installed—the airplane probably could have sawed small ships in half or served as a tank-buster, but it certainly never would have succeeded as a dogfighter. ➔






For U.S. airmen trapped in Yugoslavia during World War II,
building a secret airstrip was their only way out.

BY PHIL SCOTT

THE GREAT ESCAPE



Percy Peterson
11/19/44
MARKED by 
Bailed out
11/19/44 
lived 



ON CLARE MUSGROVE'S FIRST MISSION over Ploesti, Romania, he and the crew of his U.S. Army Air Forces bomber were certain to be shot at. Romania supplied the oil the Nazi war machine desperately needed for its tanks, trucks, and aircraft. While the Germans vowed to protect the flow of oil from Romanian wells at all costs, in 1943 and '44, the Americans grew just as determined to choke production.

To do it, they sent Consolidated B-24 Liberators of the 15th Air Force, based in Bari, Italy. With a high wing, four engines, and an H-shape tail, a B-24 looks roomy from the outside, but half the crew—the pilots, navigator, bombardier, and radio operator—sit in or near the nose. Then comes the tightly packed bomb bay. “It usually had five 2,000-pound and ten 1,000-pound bombs,” says Musgrove. “It might have even carried some 500-pounds.” A narrow vertigo-inducing aluminum plank links the cockpit with the tail section, which housed two waist gunners, the tail gunner, and the ball-turret gunner, Musgrove’s position.

The ball turret was so cramped the gunner could not wear a parachute plus the head-to-toe leather flightsuit, which was the only protection from frostbite at altitude. So the gunner stowed his

chute outside the turret, but within reach. If a bullet or chunk of flak cut a power line, the gunner had to hand-crank the turret to a position from which he could wriggle out of the escape hatch. “It was a very difficult place to remove yourself from, if you didn’t have power,” says Musgrove.

A hollow sphere of aluminum and glass, the ball turret could spin twin .50-caliber machine guns in an arc of 180-plus degrees. The turret hung more or less from the B-24’s belly, and the gunner inside operated it with electric controls mounted on pistol grips. The grips also carried triggers to fire the .50s.

During the summer of '44, Musgrove, a gunnery instructor, volunteered to fly his 11th mission as a stand-in ball turret gunner. His departure from the 15th’s air base in Italy and flight over the Adriatic and into Yugoslavia were smooth. Over

the target—part of Musgrove’s job was to see how well the crew hit it—flak took out two engines. The B-24 started losing altitude, and then a third engine died. Lieutenant Fred Tucker, the pilot, hit the alarm to abandon ship, and from the bomber’s smoky trail, parachutes blossomed.

All except Musgrove’s.

“I had to hand-crank the turret up and get out,” he says. “That took me a while. Then I couldn’t find my parachute, so that made me panic a bit.” The Germans spotted the other parachutes and rounded up all nine airmen. By the time Musgrove finally popped out of the B-24, his parachute opened miles away from the others. The Germans missed him—and they knew it.

DURING WORLD WAR II, that story played out on every front—a bomber went down, the enemy rounded up survivors. Often the airmen were attacked by shotgun- and pitchfork-wielding civilian mobs, driven to fury by relentless bombing raids; ironically, the airmen would be rescued by enemy soldiers. Where Musgrove went down in Yugoslavia, the opposite happened.

The Nazis had bombed and invaded the country on April 6, 1941, and the royalist government surrendered 11 days later. In the chaos that followed, two factions emerged: Marshal Josip Tito’s communist Partisans and General Draza Mihailovich’s royalist Chetniks. Numbering around 10,000, the Chetniks lived in mountainous western Serbia and followed the charismatic Mihailovich. He appeared on the May 25, 1942 cover of *Time*, which considered him one of Europe’s greatest guerrilla fighters. The magazine’s readers voted Mihailovich Man of the Year, though the editors picked Joseph Stalin.

Opposite: A quiet cornfield in Serbia became the site of an air rescue mission that saved 15th Air Force crews shot down during bombing raids. (Silk maps of Yugoslavia were in their survival kits.) Left: The mission was managed by the U.S. Office of Strategic Services’ Nick Lalich (front row, third from left) and radio operator Arthur Jibilian (back row, second from left).



OPPOSITE: COURTESY TED CONNOLLY; COURTESY JOHN CAPPELLO; COURTESY DEBI JIBILIAN

The Allies also went with Stalin instead of Mihailovich: A communist double agent convinced the British to align themselves with Stalin's man, Tito, and the British convinced the Americans to do the same.

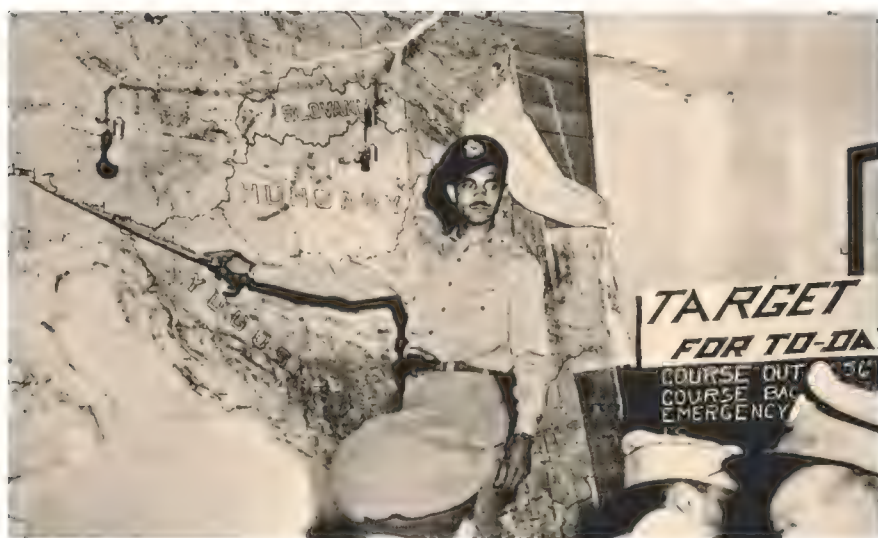
By 1944, when flak from Ploesti's anti-aircraft artillery brought down Musgrove's B-24, Tito and Mihailovich were fighting not only the Germans, but each other. The U.S. forces dropped supplies and weapons for Tito's Partisans, while the

Chetniks salvaged machine guns and ammunition from crashed B-24s and whatever food they could scrounge from the countryside and from the peasants who backed Mihailovich.

The U.S. Army Air Forces had instructed its airmen that if they had to bail out, they should do it over land controlled by Tito. But air crews in damaged aircraft rarely have a choice about where to jump. When airmen hit the silk over Serbia, "the Germans would jump in

their trucks and tanks and chase their parachutes to the mountainside," says Nick Petrovich, who grew up in Serbia and joined the Chetniks when he was 16. "We organized the peasants to pick up the guys, bury the parachute into the ground or into the hay so the Germans would not see it. Then we guerrillas would be taken by the peasants to where they hid those guys."

WHILE HE FELL from the sky in 20 to 30 seconds, Musgrove spotted a flock of sheep to his left. "I said, 'If I ever get on the ground, that's where I'm going to head out, because sheep and humans go together,'" he recalls. When he landed, he tucked and rolled as he had learned during jump training. Then he found the two women and two boys herding the sheep. He cautiously revealed himself. Since he didn't understand Serbian and they didn't know English, everyone sat and stared at one another for a long time. Then the women and boys gathered the flock and started toward their village.



The 15th Air Force Consolidated B-24 Liberators were tasked with taking out the oil refineries in Ploesti, Romania (below). Their escorts, African-American P-51 pilots trained in Tuskegee, Alabama, were briefed on their targets.



TOP: USAF; BOTTOM: NASM (SI NEG. #A-45879-F)



LEFT: COURTESY TED CONNOLLY; RIGHT: COURTESY CILLE85



Two groups fought the Nazis in Yugoslavia: the Partisans, led by Josip Tito (right), and the Chetniks, headed by Draza Mihailovich (above, in glasses). Lalich (at left), the U.S.-born son of Serbian emigrants, had no trouble communicating with Mihailovich.

"I stood pat and didn't know whether to follow them or not," says Musgrove. "They turned around and motioned for me to follow them, and I did." The peasant women led him to a house, and motioned for him to sit on the porch while villagers gathered around and talked. Then they brought him inside and motioned for him to sit at a table. "They were very generous," he says. "They didn't have much food for themselves, but they were willing to share it."

While they ate, a quick rap came on the door. The man of the house answered

and engaged in a deep conversation with the visitor. "He came back to the table, grabbed me by the shoulder, and took me into a bedroom and motioned for me to get under the bed," says Musgrove. "Later that night another person came into the house, and they had another hefty conversation. He walked around the house. I could only see his boots—they looked like German boots to me—and the man of the house convinced him no one was in the house. He finally left, and I began to breathe somewhat easier."

The next morning two Chetnik soldiers—neither of whom spoke English—arrived at the house, and they took Musgrove on a walk that lasted days. "I didn't know anything about where we were going," he says. "I didn't know if I had been captured. I was scared to death. I didn't speak the language. I was at the

mercy of whatever person was helping me. Later in the week, we came upon a local man who was a schoolteacher who could speak some English, enough to tell me there was an assembly area where downed airmen were accumulating."

They walked farther. "The next day I met a man on horseback, and he could speak very good English," says Musgrove. "He told me he was Captain George Musulin, who was in charge of the [U.S. Office of Strategic Services] group helping the Chetniks gather us to a central base, and they were going to build an airstrip and come in and fly us out."

THE CHETNIKS HAD BEGUN their collection of U.S. airmen when the first one floated out of the sky following a disastrous low-level raid on Ploesti in 1943. A year later, the number of Americans under Chetnik care topped 100, but Army Air Forces officers did not realize there were so many and that they were clustered in Pranjani, a remote village in western Serbia. Air Force leaders figured that men not turned over by Tito's Partisans had probably been rounded up by the Germans. That all changed after Musulin returned to the OSS station in Bari at the end of May 1944 after spending six months in Serbia gathering intelligence and organizing the Chetniks



COURTESY DEBI JIBILIAN

The OSS sent an intelligence-gathering team to check out Mihailovich's territory in Serbia: From left to right, Lieutenant Mike Rajacich, Lieutenant Colonel R. McDowell, Captain John R. Milodragovich, and U.S. Navy Reserve officer Mike Divjak.

into resistance groups who could sabotage German targets, including bridges, ammunition depots, and airfields.

Musulín's boss in Bari, George Vujnovich, had heard unconfirmed reports that the number of Allied airmen who had escaped capture by the Germans in Yugoslavia was substantial. When Musulin confirmed that there were at least 100 men in Chetnik territory, Vujnovich devised a rescue operation code-named Halyard. Vujnovich wanted to send in a three-man team headed by Musulin to supervise the building of an airfield from which U.S. airplanes could evacuate the airmen.

Arthur Jibilian, who had been a U.S. Navy radioman before joining the OSS, would be the team's radio operator. Jibilian, better known as "Jibby," was tasked with hauling around the heavy



Risking persecution from German soldiers, the Serbian villagers of Pranjani did their best to make the U.S. airmen feel at home, bedding the fliers in barns (above) and transporting them on ox-drawn wagons (left).

equipment needed to receive, transmit, and encode radio signals. According to Gregory A. Freeman, who wrote about Operation Halyard in his 2007 book, *The Forgotten 500*, Vujnovich felt even more urgency about launching the rescue after finding out that a few of the airmen in Pranjani had recently been sending encoded radio messages to the 15th Air Force headquarters in Bari asking for help.

In late July, the OSS sent the downed airmen a message to expect Musulin, Mike Rajacich, a Serbian-fluent OSS agent, and Jibby to jump on July 31 or the first clear night after.

Under a prior agreement between British and U.S. intelligence services, a British pilot and jumpmaster would fly the OSS team to the jump site in a U.S.

aircraft. That night, after taking off from Fugia, Italy, in a C-47 painted black, they ran into anti-aircraft fire and turned back. The next night, the jumpmaster told them to leap into an area where the Halyard team could clearly see a battle raging. "It's funny, yet it's so serious it's not funny," said Jibby (interviewed for this story a few months before he died last March). Then the jumpmaster told the OSS team to parachute above a lake. According to Jibby, Musulin exploded and demanded—and got—a U.S. pilot and jumpmaster. "That night, we were in Yugoslavia," said Jibby.

Jibby said he had been afraid during the two-hour flight to the drop zone, but the delays made him eager to jump. They used a static line and jumped at 800 feet with no emergency chute. Jibby

hit the ground in 30 seconds. "It looked like I was going to come down into some trees, so I went into 'tree position,'" he remembered. "I crossed my legs and put my elbows to my face." Fortunately, he landed in a cornfield. "My best landing of all my parachuting," he said. "Musulin landed on a chicken coop and crushed it all to hell. Mike, our third member, he landed in a tree with feet just barely off the ground and had to be helped out a bit."

When the Halyard team finally met up with the downed fliers, they learned that the group had ballooned to 250. And they weren't just showing up randomly. By then the Chetniks had developed precision tactics to rescue them: Once a parachute bloomed, one small guerrilla detachment rushed toward it, while a second larger group set up a perimeter, blocking roads with boulders or trees and placing .50-caliber machine guns at strategic points. "Most of the time the Germans would turn around and retreat," Petrovich wrote in his 2003 autobiography, *Freedom or Death*, "but sometimes the expedition would include tanks and armored vehicles, and the only thing that we could do was to keep them under fire until the signal was received that the American crew had been evacuated."

Right after one such mission on Zlatibor Mountain, Petrovich's group received



NASM (SI NEG. #99-15262)

orders to move to Mihailovich's headquarters at Ravna Gora. Once there, they were ordered 50 miles north to Pranjani, where the growing collection of U.S. airmen had discovered Galovica meadow. It was situated atop a hill and filled with boulders, but it was relatively flat, and the Halyard team thought it could accommodate C-47s.

"Basically it needed to be plowed flat and strengthened," says Dik Daso, curator of modern military aircraft at the National Air and Space Museum. At night, with no machines, Allied airmen and Serbian peasants cleared boulders and filled in potholes. "Using ox wagons, the peasants would go to the nearby stream bed, get rock and sand, and bring the stuff up the hill to the runway site, in this never-ending daisy chain," says Daso.

The airmen and Serbs completed the airstrip in nine days. On one end stood a forest, a sheer dropoff marked the other,

and mountain peaks poked up a mere two miles ahead. The strip measured 150 feet wide and 2,100 feet long. Using that takeoff distance and loaded with enough fuel to return to Italy, a C-47 could haul out up to 25 airmen at a time.

The first evacuation was scheduled for the night of August 9.

As the sun set, everyone—the OSS team, the airmen, the Serbs who had taken them in, and the Serbs who had helped build the runway—gathered at the meadow. They lit flares and bonfires to outline the strip. At precisely 10 p.m., the first transport approached, a black C-47 with a white star on its tail. Its landing gear made contact too far down the runway, so the pilot applied power and pulled up. "We thought that was the end of the mission that night," says Musgrove.

But the second pilot slammed down the gear of his C-47 and held the transport

P-51s assigned to the 15th Air Force's 306th Fighter Wing return to their bases in Italy: (From front to back) 325th Fighter Group, 332nd Fighter Group, 52nd Fighter Group, 31st Fighter Group.

on the ground. The strip's end approached. "He spun around on a wing, but didn't damage the wing," says Musgrove. "He bent it a little bit." Fortunately, the transport was still airworthy. Three more C-47s landed without incident, including the one that had failed to stop on its first attempt.

The sickest dozen airmen were loaded first onto one of the aircraft. The pilot taxied into position on one engine, fired up the second, and, pressing the brakes, shoved the throttles forward. He released the brakes. Its engines screaming, the C-47 picked up speed. When it reached the end of the strip, it dropped below the hill and disappeared. But then, just



like in the movies, it roared upward. Transports two, three, and four departed the same way.

Forty-eight men out, more than 200 to go.

Despite the success of the first airlift, Musulin and the other OSS leaders determined that trying to land in mountainous terrain at night was too dangerous. But conducting flight operations during the day had its own risks. Only 20 miles southeast of the Galovica meadow airfield was Cacak, a German garrison. "The Germans there were reduced in number, but they had an airfield and a few fighter planes," said Jibby. In the end, the Halyard team decided that attacking Germans were the lesser of two evils.

tears from both sides, as well as last-minute gestures of goodwill. "The Chetniks and Serbians had very poor clothing and shoes," says Musgrove. "They wore boots made out of felt, and things like that, so when we got on the plane we kicked our shoes off to them."

"[The airmen] had these leather suits, and they would give us that to use," says Petrovich. "The guys would give us their Colt pistols, which we loved very much." In return, the Serbs gave the airmen homemade rugs, and one guerrilla handed airman Ray Weber his Chetnik cap. Weber was "a souvenir kind of guy," says his daughter Sue Brown. Right after bailing out, Weber had started collecting mementos, tucking away a scrap of silk

from his parachute, plus the ripcord.

Mihailovich asked if he could send two seriously ill Chetniks to Italy for medical attention, and Musulin felt he couldn't refuse. When the men arrived in Bari, however, they were spotted by Tito's Partisans, who reported them. "All hell broke loose," said Jibby. "They were going to court-martial Musulin." Cooler heads prevailed, but Musulin was ordered out and replaced with Nick Lalich for the rest of the operation.

Mihailovich told Lalich, the U.S.-born son of Serbian emigrants, that if the Air Force was interested, he could deliver more airmen to Pranjani. Jibby radioed the message back to the 15th's headquarters, and received orders to continue Operation Halyard—with no promises to the Chetniks.

For a few more weeks, as soon as a few flights' worth of airmen collected at Pranjani, Jibby called for more transports. The airstrip in the meadow operated almost like any other military airfield. "We didn't do a couple of evacs because of bad weather," said Jibby, "but I can't say it was ever really a factor." The OSS even flew in a doctor and two assistants to treat burns and flak wounds and set broken bones.

While waiting for their flight home, the airmen hid out and slept anywhere:



Most of the evacuation flights from Pranjani were made during the day (below) so the C-47 pilots would have maximum visibility. After giving their shoes to the peasants who had cared for them, airmen warmed their feet in bags (left).

COURTESY DEBI JIBILIAN (2)

At 8 a.m. the next day, Jibby heard the second round of transports—12 more C-47s—accompanied by the deep, throaty roar of fighters: one group of P-38s and another of P-51s. The -51s had red tails, the markings of the Tuskegee Airmen. "They came in numbers of six and 10, accompanying the guys landing on the mountain," says Petrovich. "They would have a lot of fun flying around strafing German planes" parked on the ground at Cacak and at two other German garrisons nearby.

Airmen quickly filled the bare benches running the length of the C-47 cargo holds, and transport after transport pulled away. A couple hundred more men—in addition to the 248 who'd already been flown out—were evacuated on flights carried out over August 12, 15, and 18. The farewells between the airmen and the Serbs who had risked their lives helping them often brought



On the ground near the strip, in villagers' homes, in barns, atop fir needles in the nearby forest. The wounded always took priority, sleeping in beds while their hosts slept on the floor. Always, they were guarded by the Chetniks.

"Sometimes you would eat once a day," said Jibby. "Sometimes twice or three times—sometimes you wouldn't eat at all. You learned that you can overcome hunger. Keep going and after a while the hunger goes away. It hurts, but sooner or later, the host will come to you with a hunk of cheese and black bread with straw in it and you eat. Or chicken broth or beef broth with potatoes. Once in a while there would be a great celebration—they had chicken and lamb and we had a feast. Our stomachs would be shrunk so much we couldn't eat much."

The last flights out of Pranjani were in late August. "I have no knowledge that [the airfield] was used after the war except to graze the cattle," says Petrovich. Life in the village returned to normal, while the Nazis suffered heavy losses in the east.

"[The Germans in Serbia] were demoralized," says Petrovich. "They were in a strange country. They didn't know if they were going to get home. Some would start crying, 'I didn't come here

on my own volition,' trying to justify themselves. At the beginning they were killing 100 Serbians for every German soldier killed, but when they became weakened and the garrisons depleted, then the whole game changed."

At the end of 1944, the Soviets marched into Serbia. Two years later, Tito's Partisans captured Mihailovich, accused him of collaborating with the Nazis, and executed him. The U.S. government downplayed protests by the rescued airmen in New York City and Washington, D.C. In 1948, the United States secretly and posthumously awarded Mihailovich the Legion of Merit, the highest U.S. commendation for a foreign citizen. "General Mihailovich and his forces," it read in part, "although lacking adequate supplies and fighting under extreme hardship, contributed materially to the Allied cause, and were instrumental in obtaining a final Allied victory."

When Mihailovich was captured, Petrovich and the other Chetniks were imprisoned and later forced to join the Partisans, but Petrovich escaped to Athens, Greece. "I was shot only three times and still alive and no airman was killed," he says. "But the Nazis, Bosnian SS, and Croatian Nazis left their bones in the gorges and river beds." Petrovich, now 83, lives in Mexico City.

In 2004, the Serbian government held a 60th anniversary reunion at the Pranjani strip to dedicate a plaque; two airmen, Clare Musgrove and Bob Wilson, made it. The next year, Mihailovich's Legion of Merit was officially presented to his daughter, Gordana Mihailovich. Jibby was one of five Halyard veterans at the presentation. In July 2009, U.S. Congressman Bob Latta of Ohio introduced a bill to award Jibby the Medal of Honor for his actions during Operation Halyard. And last October 17, in a ceremony in



COURTESY TED CONNOLLY

Hundreds of Allied airmen owed their survival to the villagers who lived in the mountains of mid-century Serbia.

New York City, 95-year-old George Vujnovich received the Bronze Star for his role in the rescue.

Souvenir collector Ray Weber left the military and built a tool-and-die business. "On June 11, we would have burnt toast and cottage cheese," says his daughter Sue Brown. "It was symbolic of the day that he got shot down, and what he ate there most of the time—burnt bread and goat-cheese-something. But cottage cheese was the closest Mom could do to it."

In 1955, Weber received a letter from one of the Serbian families he'd lived with while he was on the run. It was in Serbian, so Weber had it translated. The writer simply reminded Weber that he had hid with his family and asked how he was. Weber, who died in 1996, made copies of the letter and sent one to each member of his crew. His daughter doesn't know if any of the men responded. The original letter, written on fading airmail paper, he saved in a box labeled "War Stuff."

George Musulin, who died in 1987, worked with the OSS's successor, the CIA, for a few years after the war. "My dad didn't talk about the mission to his family directly, but we always heard it in conversation when he got together in social circles with our friends," says daughter Joanne Esteban De La Riva. "Certainly I know it was a highlight of my dad's life, that operation." —



How Things Work:

Whole-Air

BY MICHAEL KLESIOUS | ILLUSTRATION BY JOHN MACNEILL

WHEN EVERYTHING ELSE FAILS, OR FAILS ALL AT ONCE, PULL THE PARACHUTE THAT SAVES THE WHOLE AIRPLANE.



1 The pilot cuts engine power and pulls a handle on the cabin ceiling.

2 An activation cable (shown ghosted through fuselage) triggers an igniter, which launches a seven-inch-long, 2.5-inch-diameter rocket from a compartment in the aft cabin.

3 The rocket extracts a parachute of nylon reinforced with Kevlar. Two Kevlar straps break free from fiberglass casings on each side of the fuselage. Inflation of the canopy in the semi-open profile decelerates the airplane much as a drogue chute would.



COURTESY DOUG FRONIUS

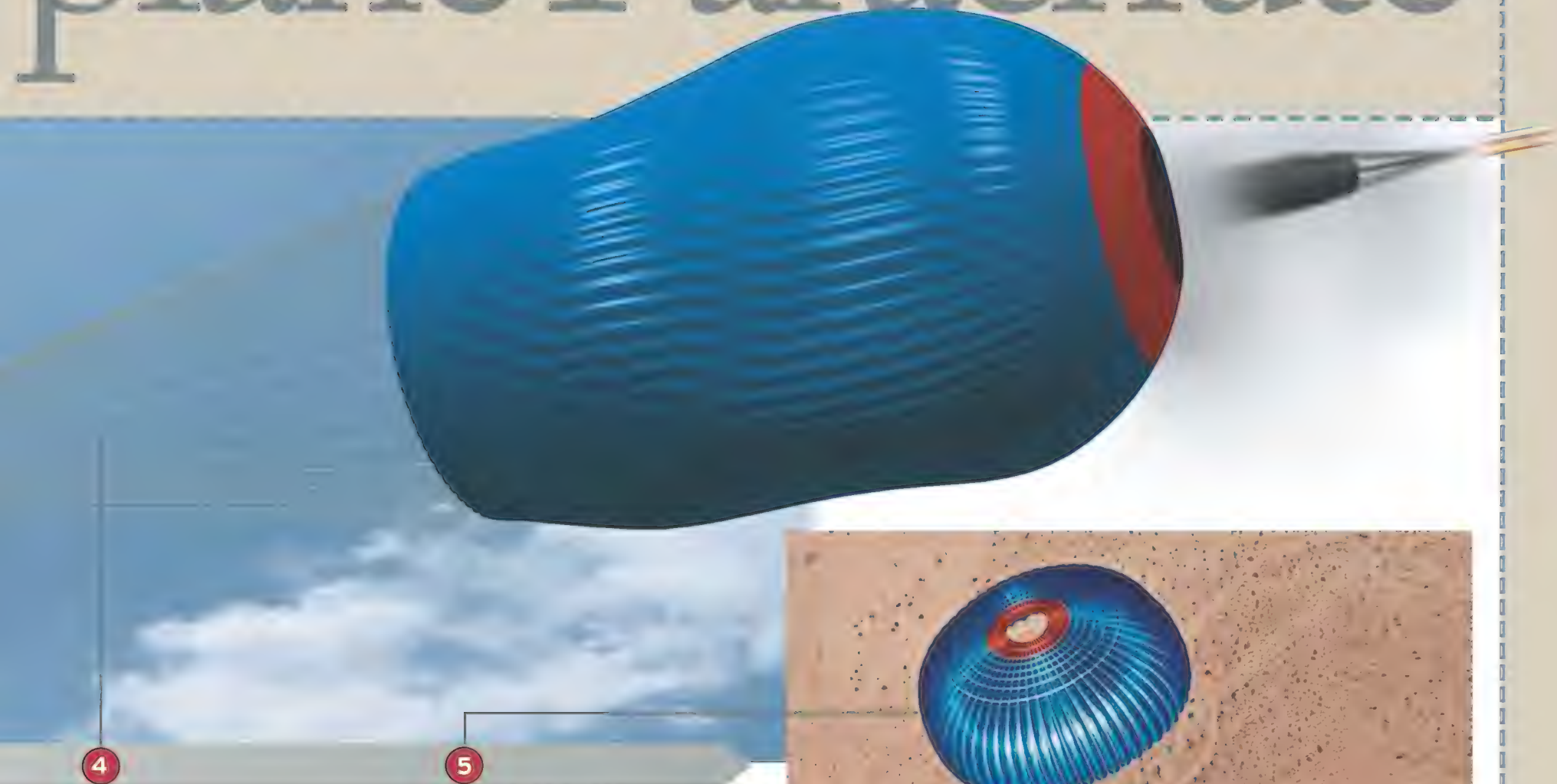
Bob Fronius descends in a Piper Cub in 1949. To avoid damage in a landing on uneven terrain, he unhitched the chute, restarted the engine, and returned to the airfield where he had taken off.

IT'S NOT JUST FOR STUNT MEN ANYMORE. Every pilot may eventually need a whole-airplane parachute. Dino Moline did last August when the wing of his RANS S-9 aerobatic airplane snapped off during a performance in Argentina. With no way to eject as his craft spun out of control, he popped the big chute. Strapped in his seat, he floated to the earth, then walked away.

The idea's been around for a while. In 1929, Hollywood stunt pilot Roscoe Turner deployed a whole-airplane parachute for kicks before 15,000 spectators in Santa Ana, California, and landed softly in his 2,800-pound Lockheed Air Express. In 1948, pilot and parachutist Bob Fronius twice deployed a chute from a JR-V Robin sailplane near San Diego, and several times the following year from a J-3 Piper Cub. "He would climb, shut the engine down, open the chute, play around with it, then release the chute and



plane Parachute



4

A circular “slider” (photo, right) moves down the parachute cords, allowing a deployment that is gradual enough to prevent damage to the parachute and airplane.

5

The third, aft harness fully extends and puts the airplane in a level attitude for a three-point touchdown. Total time from rocket firing to full deployment: three to nine seconds, depending on the speed of the airplane.



COURTESY CIRRUS AIRCRAFT

dive to start the engine,” says Fronius’ son Doug. Bob Fronius never commercialized his parachute. “He was a better experimenter than a businessman,” says Doug. “He considered the job done once he accomplished the experimental part.”

Not true for Boris Popov. In 1975, he fell 400 feet after losing control of a hang glider, cursing his lack of a whole-airplane parachute all the way down. He survived the impact with a Minnesota lake. “I came back to the surface,” he says, “and spit out a bunch of fillings.” Popov founded Ballistic Recovery Systems, maker of the parachute system shown here. The chute was approved by the Federal Aviation Administration in 1993 for the Cessna 150. Later, Cirrus Aircraft began to build the chute into its SR20s and SR22s. More than 30,000 BRS chutes have been installed on a wide variety of airplanes and have saved 257 lives.

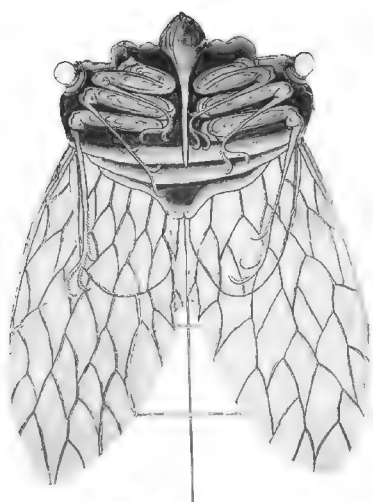
A Cirrus SR20 floats down during a late-1990s test of the Ballistic Recovery Systems chute. A Cirrus customer first used one in an emergency near Dallas, Texas, in 2002.

PARACHUTES AVAILABLE STANDARD AND RETROFITTED

- Cirrus SR20/22
- Cessna 152, 172, 182 series and their forebears
- 370-plus ultralights, homebuilts/experimentals, and hang gliders
- 15-plus light sport aircraft, including the Flight Design CT, Cessna Skycatcher, and Piper PiperSport

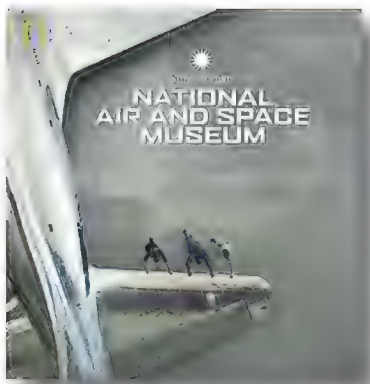


LEFT: DANE PENLAND; OPPOSITE TOP LEFT: NASM A-10983-E; OPPOSITE TOP RIGHT: NASA MARSHALL



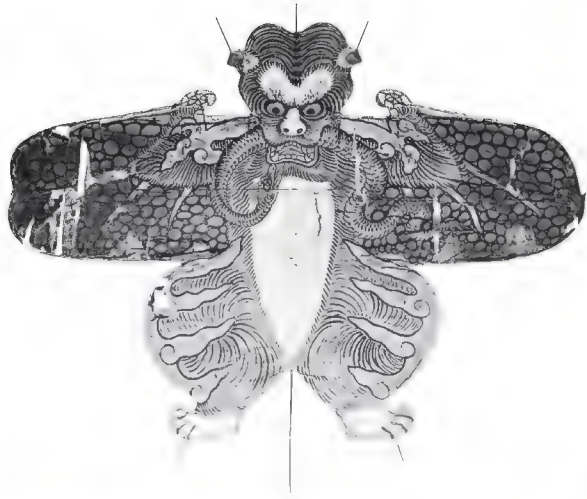
From Kites to the Space Shuttle

A HISTORY OF THE NATIONAL AIR AND SPACE MUSEUM



The new history (above) devotes a section to the Museum's most controversial airplane, the Boeing B-29 *Enola Gay* (opposite, tail facing out), on display at the Steven F. Udvar-Hazy Center in northern Virginia. Nearby are the twin-boom Northrop P-61 Black Widow and bright yellow Northrop N-1M flying wing. The Center will eventually hold 80 percent of the Museum's aircraft collection.

WITH A STROKE OF HIS PEN, President Harry S. Truman in 1946 created the National Air Museum. But the Smithsonian's collection of aviation-related objects dates back far earlier, to 1876, when the Institution received a donation of 42 hand-painted kites from the Chinese Imperial Commission. Today, hundreds of aircraft, spacecraft, and rockets, plus thousands of related artifacts, have joined those antique kites in what is now the world's largest aerospace collection, the National Air and Space Museum. ● A new book, *Smithsonian National Air and Space Museum: An Autobiography* (edited by Michael J. Neufeld and Alex M. Spencer, National Geographic, 2010), offers an in-depth look at the history of the Museum, from Samuel Langley's early model-airplane experiments in the halls of the Smithsonian Castle to the acquisition of the *Spirit of St. Louis* to the journey of the Mars rovers and beyond. ● Each year, eight million people visit the Museum to see the aircraft and spacecraft that made history; over the next few pages, take a look into the newly published history of how the Museum came to be — *The Editors*



NASM (SI NEG. #SI-2003-6592-PM)



TOP LEFT: NASM A-10983-B; LEFT: NASM (SI NEG. #SI-A-742-B)

JUST ONE OF 42 HAND-PAINTED traditional kites (top, left), donated to the Smithsonian (along with thousands of other items) by the Chinese Imperial Commission in 1876. The first flying objects crafted by human hands to enter the Smithsonian collections, the kites were obtained at the conclusion of the 1876 Centennial Exposition in Philadelphia by Smithsonian Secretary Spencer Fullerton Baird, who persuaded exhibitors to avoid the expense of shipping their exhibits home by donating them.

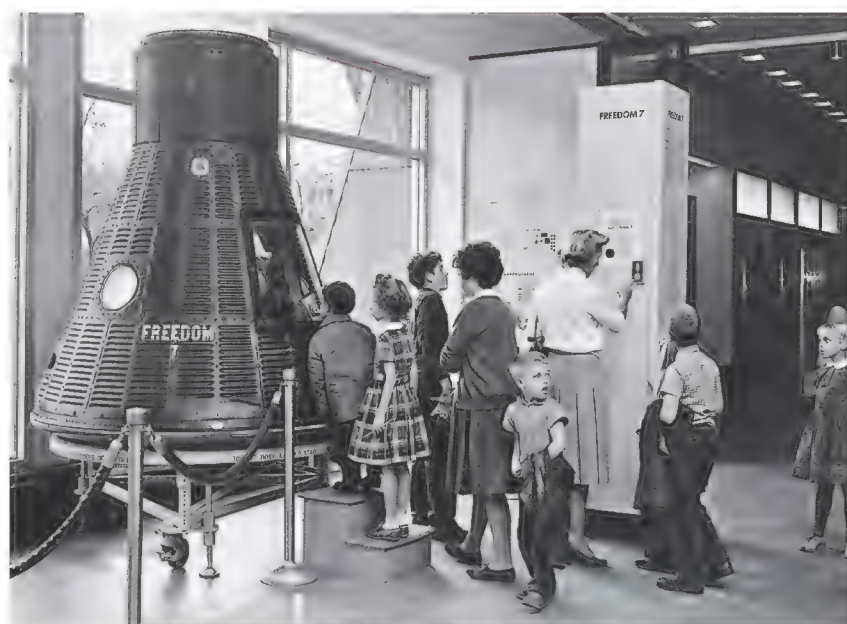
IN 1919, the Smithsonian received from the U.S. Army and Navy a significant collection of World War I aircraft which were housed in a temporary metal building behind the Smithsonian Castle. For a time, the renamed Aircraft Building, also known as the Tin Shed (top, in 1935), contained a huge Martin bomber, a LePere fighter-bomber, an Aeromarine 39B float-plane, and the skeleton of a de Havilland DH-4 light bomber.



LEFT: NASM (SI NEG. #SI-91-14704-PM); OPPOSITE BOTTOM: ALEX M SPENCER (10)



AS CHARLES LINDBERGH flew solo across the Atlantic on May 20, 1927, Smithsonian aeronautics curator Paul Garber composed a cable to send to the pilot, requesting the *Spirit of St. Louis* for the national collection. It was one of the first messages Lindbergh read after he woke up at the American Embassy in Paris following some much-needed post-flight sleep. The arrival of the *Spirit of St. Louis* marked a significant milestone in the history of the Museum, for its installation in the Arts and Industries Building (opposite, middle) on May 13, 1928, focused the nation's attention on the Smithsonian and its aeronautical collection.



TOP: DANE PENLAND; SI 2004-18354LEFT: NASM (SI NEG. #SI-2006-28132-P)

THE U.S. NAVY'S Curtiss NC-4 became the first aircraft to fly across the Atlantic Ocean, in May 1919. In 1926, Paul Garber persuaded the Navy to preserve the aircraft. The Aircraft Building was too small to house the massive flying boat, so the wings went to Alexandria, Virginia, for storage; the engines and propellers went to Norfolk, while the fuselage remained at the Smithsonian. In 1969, on the 50th anniversary of the flight, the aircraft was restored and placed on temporary display on the National Mall (opposite, bottom). Today, the NC-4 is on indefinite loan to the National Naval Aviation Museum in Pensacola, Florida.

THE OLDEST SURVIVING Pitts Special, *Little Stinker* (top), suspended upside down from the ceiling of the Udvar-Hazy Center's entrance hall, is the first airplane visitors see. The Center opened in December 2003, and in its first two weeks welcomed more than 200,000 visitors; on June 9, 2004, the one millionth visitor passed through its doors. When the Center opened, 80 airplanes were on display; today, the number is almost 200.

ALAN SHEPARD'S Mercury capsule was displayed in the Museum's Aircraft Building in the early 1960s (above). Between 1967 and 1980, the Museum acquired more than 5,000 NASA artifacts, including every spacecraft flown by U.S. astronauts and virtually all of the ones ground tested or flown without pilots. With the close of the space shuttle program, hundreds of new artifacts will be coming to the Museum in the next few years.

ONE OF THE MUSEUM'S largest artifact assortments is the insignia collection, which has some 7,000 pieces from more than 65 countries, primarily from the military services and from commercial airlines. The commercial collection represents more than 200 airlines (a sample, below, and on the following page), many of which went out of business decades ago. These badges may be the organizations' only remaining artifacts.

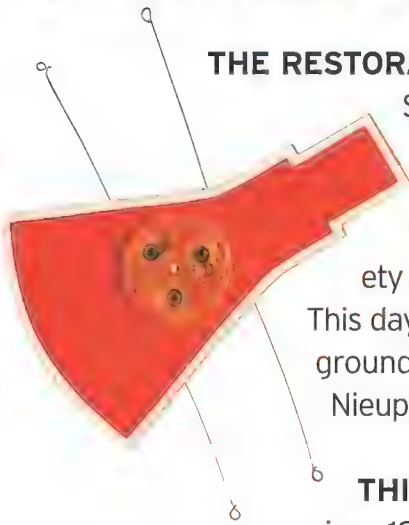




BOTTOM LEFT: DANE PENLAND; LEFT: NASM (SI NEG. #SI-2000-9368-Q)



NASM (SI NEG. #SI-A-598351-P)



THE RESTORATION SHOP at the Garber Facility in Suitland, Maryland (above, some years before the move to the Udvar-Hazy Center in 2010), was the place where the collections staff always had a variety of wood and metal projects under way. This day, work was proceeding on (in the foreground) the Hawker Hurricane, left, and the Nieuport 28.

THIS MERCURY CAPSULE ICON (left), circa 1960, followed a fixed path along the tracking map of the Mission Control Center at Cape Canaveral, Florida.

PAUL GARBER arrived at the Smithsonian in 1920, and eventually became the first curator of the institution's aeronautical collections and later the founder of the National Air and Space Museum. He worked at the Smithsonian for 72 years. Here (top, right), he and helmeted exhibit designer Benjamin Lawless prepare to ride in a balloon on the National Mall on April Fools' Day 1966.

WHILE PAINTING "The Space Mural – A Cosmic View" on a wall in the National Air and Space Museum in 1975, artist Robert McCall (right) invited astronaut and artist Alan Bean to paint a single star high up near the rooftop domes. Artist Eric Sloane, working high on scaffolding on a mural on the opposite wall, was kept entertained by an assistant playing a concertina.



LEFT: NASM (SI NEG. #SI-2009-31389-P); BOTTOM: BOTTOM: ALEX M SPENCER (15)



MUSEUM DEPUTY DIRECTOR Don Lopez gave a tour of the Museum to singer Michael Jackson in 1984 (right). Visits by stars and heads of state are common, keeping the security force busy.

THE IMMEDIATE impetus for the National Air Museum came from General Henry H. “Hap” Arnold, head of the U.S. Army Air Forces in World War II. In 1945, he began to collect representative surplus and captured wartime aircraft. However, it wasn’t until September 11, 1972, that bulldozers began ground-breaking (right); the renamed National Air and Space Museum opened on July 1, 1976. At the opening, President Gerald Ford called the Museum the “perfect birthday present” to the nation.

TODAY, the millions of visitors who pass through the doors of the National Air and Space Museum on the Mall (below) and the Steven F. Udvar-Hazy Center take in the largest collection of air and space objects owned by any museum in the world. Such a display was inconceivable in 1911, when the 1909 Wright Military Flyer arrived at the Smithsonian. Assistant Secretary Richard Rathbun opposed accepting the Flyer, arguing that space constraints made it “out of the question to hope for a comprehensive exhibit of actual aeroplanes.” Happily, time has proved him wrong. ✈



NASM (SI NEG. #SI-84-4714-8-P)



NASM (SI NEG. #SI-72-11326-002-PM)



NASM (SI NEG. #2006-6405)



Sightings

PICTURES WORTH A SECOND LOOK

WHEN TWO OR MORE Lockheed P-38 Lightnings form up, you can be sure the photographers aren't far behind. Frank Mormillo of Chino, California's Planes of Fame Air Museum captured five of the world's seven airworthy P-38s (right) last September 9 as they left Chino for a weekend at the California Capital Airshow in Sacramento. Serious buffs believe this was the largest formation of Lightnings flown since the end of World War II. From foreground: *Glacier Girl*, flown by Steve Hinton; *23 Skidoo*, Chris Fahey; *Thoughts of Midnight*, Kevin Eldridge; *Honey Bunny*, Jeff Harris; and *Ruff Stuff*, Rob Ator. Tyson Rininger was waiting for the airplanes in Sacramento and shot them in a sunset lineup (below). Later in the weekend, Sagar Pathak photographed *Honey Bunny* as it raced down the runway against Bill Braack in the Smoke-n-Thunder Jetcar.





From Airships to Waterslides

GERMAN ENTREPRENEUR Carl von Gablenz had an unusual vision: a fleet of giant helium airships that would haul outsize industrial loads, such as oil rigs or wind turbine blades, to remote areas of the globe. Ten years ago, his plan seemed to be progressing; at an abandoned Soviet military airfield 40 miles south of Berlin, his investor-backed company, CargoLifter AG, erected a \$110 million airship hangar measuring 1,181 feet long by 688 feet wide by 351 feet high. CargoLifter used it to store a prototype of an airship (later destroyed in a storm) capable of hoisting 60 tons.

But the end of the bull market spelled the end of von Gablenz's dream: By 2002 his company was insolvent. A German court ordered the giant hangar sold to a Malaysian company, Tanjong, which bought it for 17 million euros (about \$24 million) as a site for its Tropical Islands Resort.

A Malaysian company found a novel use for the former airship hangar: A tropical theme water park.



CargoLifter built the world's largest free-standing building, big enough to hold 14 Boeing 747s, for its prototype CL-75 airship.

Tanjong soon found that keeping the hangar at 78 degrees Fahrenheit year-round was a challenge. So workers welded shut the two steel doors, which weigh 600 tons each. To open the hangar to light, "we exchanged the [steel] skin of the hall with 20,000 square yards of translucent film," says Tanjong spokesman Patrick Kastner. "This makes natural tanning possible." Some 900,000 visitors, mostly from northern and eastern Europe, come each year.

Von Gablenz, who now runs his company from an office in Berlin, is still optimistic about the future of airships as cargo haulers. For craft that can lift 40 to 50 tons, he says, "there are very large market segments...in Canada and Siberia." He's bitter that his hangar was "sold for a swimming pool."

But what a pool: At 3,000 square yards, it's larger than four Olympic-size pools, and its artificial horizon conjures a faraway island. At the "shoreline" are 600 feet of sandy beach and hundreds of deck chairs. The Bali Lagoon has a grotto and waterfall, as well as the world's largest indoor rainforest, with 50,000 trees in 600 varieties—from palm to papaya—that thrive in natural light. Its most popular attraction is a nine-story waterslide that propels sliders to 44 mph.

If Tropical Islands stays afloat, others may eye the world's few remaining airship hangars for similar uses, though some aviation analysts predict a revival of airships, which would compete for such space. Last year, the U.S. Army awarded a contract worth up to \$517 million to Northrop Grumman to build 300-foot airships for lengthy surveillance missions over Afghanistan. The first is being built at England's Cardington Airship Works, a hangar that dates to 1915.

ROGER A. MOLA

LEFT: COURTESY TROPICAL ISLANDS RESORT; TOP: COURTESY CARGOLIFTER

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The Birth of the Jet Age

A new book explains why Boeing succeeded de Havilland in supplying airlines with the first generation of jet-powered passenger transports.



Jet Age: The Comet, the 707, and the Race to Shrink the World

by Sam Howe Verhovek. Avery, 2010. 272 pp., \$27.

SO HERE I AM, a writer searching for the topic of my next book, and Sam Howe Verhovek comes up with one right under my nose: the beginning of the Jet Age. He writes about the pilots, engineers, and politicians from Britain and the United States who worked furiously to develop the world's first successful jet airliner. I wish I'd thought of it.

Verhovek starts with the mysterious, deadly crashes of Britain's new de Havilland Comets, then jumps to the

larger tale of the infant Jet Age and its bigger-than-life characters: 707 test pilot Tex Johnston and Comet visionary Geoffrey de Havilland.

When technicalities occasionally threaten to bog down the text, the

author turns on the eloquence or recounts amusing anecdotes. Take the relatively prosaic autopilot. During a 1916 test flight, inventor Lawrence Sperry and passenger Mrs. Waldo Polk became the first known members of the Mile High Club. In the process, one of them inadvertently shut off

the autopilot, and the seaplane dove into Long Island's Great South Bay before Sperry could grab the controls.



Beautiful but flawed, a de Havilland Comet airliner (above, at left) flanks another de Havilland design, the DH 108 experimental jet.

Both survived relatively unscathed, and, yeah, the tabloids had a field day when two hunters in the area pulled the shaken, soaked, and naked couple from the debris.

A finely written book—I finished it in the time it takes to fly from New York to Denver—it will require a strong constitution from those who choose it as airliner reading. Vivid descriptions of disintegrating airplanes and dismembered bodies make for unpleasant images at 35,000 feet.

PHIL SCOTT WROTE *HEMINGWAY'S HURRICANE* AND FIVE OTHER BOOKS.

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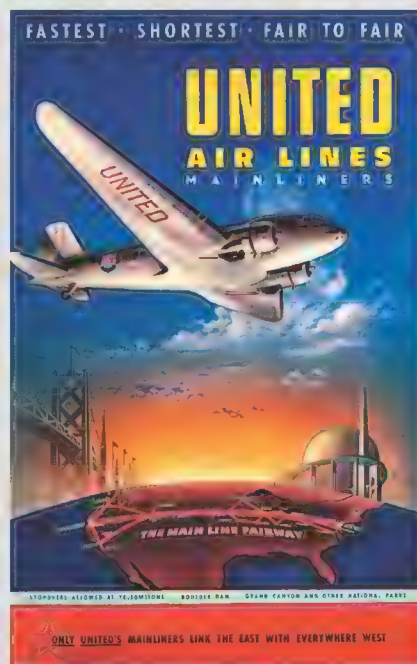
DC-3, A Legend in Her Time: A 75th Anniversary Photographic Tribute

by Bruce McAllister. Roundup Press, 2010. 250 pp., \$49.95.



ON DECEMBER 17, 1935, test pilots Ed Steinman and Frank Collbohm made the first flight of the Douglas Sleeper Transport, a 14-berth version of the DC-3. To mark the 75th anniversary of Steinman and Collbohm's flight, photographer Bruce McAllister assembled a stunning collection of images for his

latest book, *DC-3, A Legend in Her Time*. The book features McAllister's contemporary color photographs of the popular airliner as well as dozens of black-and-white archival images, many of them documenting the DC-3's role as a military transport, the C-47. Marketers in the 1930s, by making flying in the DC-3 look carefree and luxurious, introduced the idea that flying was a safe mode of travel. The collection gives the impression there was nowhere the rugged DC-3 couldn't operate: over the pyramids of Egypt, at an airstrip on a South Pacific island, in a valley in New Guinea, and past the jungles of Burma.



AUTHOR'S COLLECTION (3)

From top left, clockwise: Workers load a piece of aircraft landing gear onto a C-47 at the Royal Air Force base in Honington, England; a DC-3 on display at an airport in Jeddah, Saudi Arabia; an artist touches up a model of a Douglas Sleeper Transport destined for American Airlines; the crew and passengers of an American Airlines DC-3 ham it up for a publicity photo; a 1939 advertisement boasted that United's transcontinental service was the best way to travel to and from San Francisco's and New York's world fairs.



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It's amazing how technology has changed the way we live. Since the end of the Second World War, more products have been invented than in all of recorded history. After WWII came the invention of the microwave oven, the pocket calculator, and the first wearable hearing aid. While the first two have gotten smaller and more affordable, hearing aids haven't changed much. Now there's an alternative... Neutronic Ear.

First of all, Neutronic Ear is not a hearing aid; it is a PSAP, or Personal Sound Amplification Product. Until PSAPs, everyone was required to see the doctor, have hearing tests, have fitting appointments (numerous visits) and then pay for the instruments without any insurance coverage. These devices can cost up to \$5000 each! The high cost and inconvenience drove an innovative scientist to develop the Neutronic Ear PSAP.

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Invention	Date	Easy to Use?	Invisible?	Affordable?
The Ear Horn	17th Century	No	Hardly	Maybe
Wearable Hearing Aid	1935	Weighed 2.5 pounds	No	No
Digital Hearing Aid	1984	No	No	Not for most people
Neutronic Ear	2010	Yes	Yes	Yes

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Reviews & Previews

Phoenix Squadron

by Rowland White. Bantam Press, 2009. 407 pp., \$21.95.

A BRIEF DESCRIPTION of this fascinating true account—"Royal Navy sends carrier to foil Guatemalan invasion of British Honduras"—sounds like a Hollywood producer's pitch for a latter-day Peter Sellers comedy: *The Mouse That Roared* meets *Top Gun*. But there's far more to this tale than you might think.

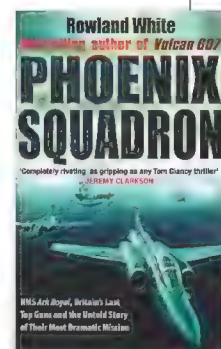
The *Ark Royal* was the Royal Navy's last big strike carrier, slated for the scrapyard in 1972, but still in business because NATO needed it in the Atlantic. The Empire's outposts were disappearing as well, including tiny British Honduras, which was about to become Belize and be given sovereignty.

Not if Guatemala had anything to say about it, however, since that country had long considered British Honduras to be Guatemalan Honduras.

Guatemala had the best army in Central America. Its paratroopers were trained and equipped by the United States. The country even had an air force—P-51Ds, Cessna A-37s, and a handful of old Lockheed T-33 two-seat jets. (One problem the Brits faced was how on earth to shoot down a slow, hard-turning old P-51 when they were flying gunless F-4s armed with heat-seeking missiles that now had no jetpipe to seek.) For the Guatemalans, rolling over the Royal Army's company of Grenadier Guards stationed at the only airport in British Honduras would be about as difficult as playing capture the flag against Boy Scouts. Their British weapons were so ancient that one gunner said, "If I get a Guat pilot in my sights, he'll die...laughing."

Still, it was the longest mission ever launched from the deck of a British carrier. Read about it and you'll pick up some remarkable insights into classic carrier operations.

STEPHAN WILKINSON IS A FREQUENT AIR & SPACE CONTRIBUTOR.



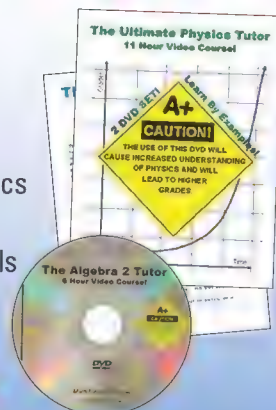
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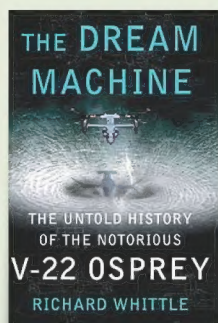
TO GIVE OUR READERS the opportunity to dig deeper into books about aviation and space, *Air & Space/Smithsonian* has started an online book club. The latest selection is *The Dream Machine: The Untold History of the Notorious V-22 Osprey* by Richard Whittle. Those who would like to participate should read the book in preparation for the online discussion on the *Air & Space* Web site in January. The book's author will be available to answer questions from readers. For more details, visit airspacemag.com/bookclub.

The Dream Machine

by Richard Whittle. Simon & Schuster, 2010. 464 pp., \$27.

THE V-22 OSPREY tiltrotor may have begun as a program with broad military applications, but it resolved fairly early into one that received its care and feeding from the U.S. Marine Corps. This thorough account of the aircraft's development is therefore a story of the Marine Corps as well.

Whittle does an excellent job summing up the aircraft and



examining its strengths and flaws. The key flaw in the Osprey's design was one introduced by the U.S. Navy's stipulation that the rotor diameter be limited to a dimension based on the size of the decks on a handful of vessels that would launch and recover the Osprey at sea. The Bell-Boeing consortium could have insisted that the rotors, being the very heart of the design, be uncompromised and that the ships be modified instead. But the Navy won that one, and Whittle reveals how the aerodynamic repercussions of that

decision played out fatally.

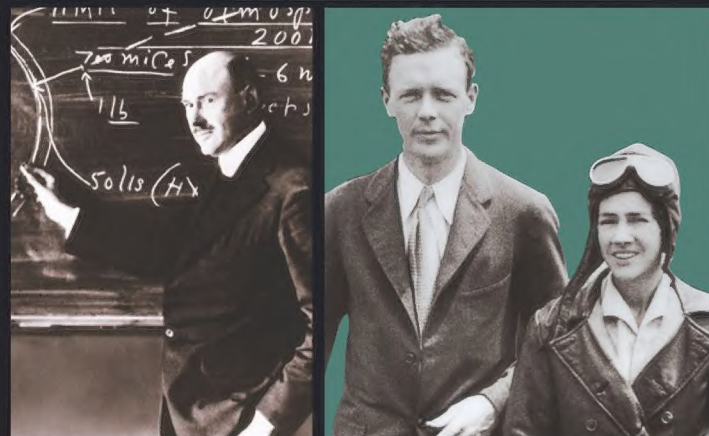
Perhaps as tragic as the deadly accidents during development was the sully of the corps' treasured reputation as incorruptible. That happened when some Marine officers altered data they feared might make the aircraft look bad. Whittle makes the case that the outcome of a military program can make or break careers, and pressure to succeed can be a dark force that has overwhelmed men of stalwart character since the procurement of the first muzzle-loader.

■ ■ ■ GEORGE C. LARSON IS THE FOUNDING EDITOR OF *AIR & SPACE*.

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Credits

The Iditarod Air Force. John Phillips is an editor at large for *Car and Driver*. He is the author of the true-crime book *God Wants You to Roll*.

How I Failed "Purdue's Got Talent." A writer and engineer, Jeremy Davis lives in Indianapolis. His latest paper creation is a book-length manuscript about traveling with agoraphobia.

The Other Gulf War. Mark Huber has written about many airplanes for *Air & Space/Smithsonian*, but not as many as the types that flew in the Gulf of Mexico last summer.

Major Surgery. Trudy E. Bell is a former editor at *Scientific American*.

The New Afghanistan Air Force. Stewart Nussbaumer has reported on more than a dozen wars over three decades and has spent nearly a year in Afghanistan covering the war as a freelance writer.

Shuttlenauts. *Air & Space* Senior Editor Tony Reichardt has been writing about the shuttle since the launch of STS-1 in 1981. He is the editor of the 2002 book *Space Shuttle, The First 20 Years: The Astronauts' Experiences in Their Own Words*.

After working as a photojournalist at several newspapers and as a staff photographer at a national sports magazine, Robert Seale now specializes in location portraits for magazines and corporations.

Too Hot to Handle: McDonnell XP-67 Moonbat. Longtime contributor Stephan Wilkinson, a former editor of *Car and Driver*, has come to love the cars in his dotage and now writes solely about aviation and military history.

The Great Escape. Frequent contributor Phil Scott was blown away by his interviews with the survivors, and how casually they told their stories.

How Things Work: Whole-Airplane Parachute. Michael Klesius is an *Air & Space* associate editor.

From Airships to Waterfalls. Roger A. Mola is the *Air & Space* researcher.

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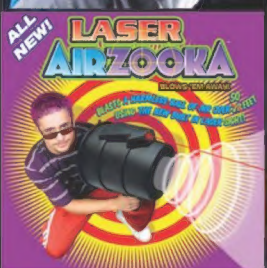
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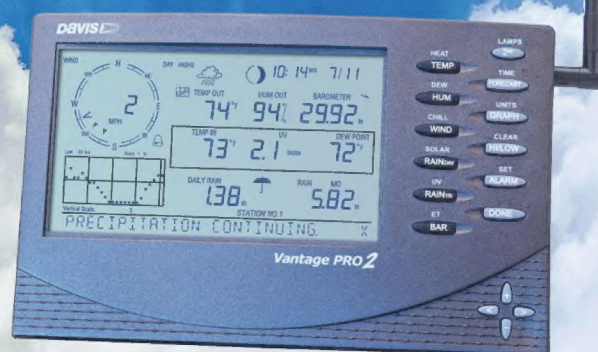


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Max Takeoff

WHEN WIDE-BODY jet transports entered service, the Federal Aviation Administration determined that their turbulent wakes were violent enough to require that other airplanes be well separated from them. When a wide-body's pilot talks to air traffic control, he appends the word "heavy" to the flight number. When controllers hear "flight 607 heavy," they know they

extra-long 15,000-foot runway. In this particular test, they used about 10,500 feet of pavement to get into the air, so they weren't cutting it close, but when you watch that much runway go by and there's only 4,500 feet left, it can get your attention. Andy Hammer, Boeing's 747-8 flight test manager, described the flight as routine: "In flight test, we test the airplane's

actual design takeoff weight of 975,000 pounds." Another 747-8 freighter, aircraft RC501, had already taken off at that weight, setting the previous record. Technically, the weight of the RC521 as it taxied out was 1.005 million pounds, so it burned off about 3,000 pounds of fuel before it took off. And after takeoff, it burned enough fuel climbing to its cruise altitude to bring its weight down to 975,000 pounds.

Before the FAA awards it a type certificate, every airplane is tested to see how it performs at various weights. Sometimes test aircraft are weighted down with water tanks, but for this flight, heavy steel plates were anchored to the freighter's cargo deck. Aircraft are also flown with the payload weight moved forward or aft to the maximum design limits to see how they perform.

The 747-8 is the result of a prolonged competition between Boeing and Airbus during which Airbus ended up developing the A380, which is now the world's largest airliner. Boeing opted to build the smaller 787 but to incorporate a lot of features never seen in a transport aircraft before. Among these are a composite structure and new General Electric engines that, together, should cut the cost of operation by about 20 percent, compared to the previous generation airliner, the 767. The 747-8 has a new wing and will also use the GENx-2b engines of the 787, although the ones on the 747-8 will provide bleed air from the engine's compressor to pressurize the cabin, whereas the 787 will use separate electric compressors. With the delays it has incurred, the 747-8 freighter should reach customers in mid-2011.

■ ■ ■ GEORGE C. LARSON, MEMBER, NAA



have to provide the aircraft following that flight with greater separation than they'd allow behind a smaller airplane.

But Boeing test pilot Paul Stemer really meant it when he called in "heavy" during a takeoff on August 16, 2010, from Victorville, California. He was flying a freighter version of the Boeing 747-8, test aircraft RC521, along with Bob Stoney, a pilot with the Federal Aviation Administration, and when the wheels left the ground, they recorded the heaviest takeoff weight ever in the history of Boeing: 1.002 million pounds.

One of the reasons they chose Victorville for flight tests on this new version of the 747 was the airport's

The Boeing behemoth on its first flight (with Lockheed T-33 chase plane), last February.

capabilities above and beyond the normal operating conditions."

In fact, other big airplanes have greater takeoff weights. The Airbus A380 freighter advertises a takeoff weight of 1.3 million pounds, and the six-engine goliath from Ukraine, the Antonov An-225 Mriya (or "dream"), takes the crown at 1.323 million. The giant Antonov was designed to carry the Soviet Buran space shuttle, and only one was ever built.

According to Boeing spokesman Tim Bader, "The mission on the August flight was to demonstrate cruise at the